HAMADRYAD
Vol. 18, December, 1993.

CONTENTS

NOTES

BOOK REVIEWS

CURRENT LITERATURE IN ASIAN HERPETOLOGY

ANNOUNCEMENTS

Hamadryad, Vol. 18, pp. 1-9, 1993

CNEMASPIS GORDONGEKKOI, A NEW GECKO FROM LOMBOK, INDONESIA, AND THE BIOGEOGRAPHY OF ORIENTAL SPECIES OF *CNEMASPIS* (SQUAMATA: SAURIA: GEKKONIDAE)

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(with one plate and two text-figures)

ABSTRACT: A new species of *Cnemaspis* is described from the Indonesian island of Lombok, in the Lesser Sundas. The new species, *C. gordongekkoi*, is compared with its congeners from the south-east Asian archipelago. *Cnemaspis* shows a distinctly disjunct distribution in south and south-east Asia, known species forming a western component (south-western India and Sri Lanka), a central component (from southern Malay peninsula, the Andaman and Nicobar Islands, and the Greater Sundas) and an eastern component (Lombok and Timor).

The absence of *Cnemaspis* species in regions between the western and central components is attributed to marked seasonal climate including cold winters and more xeric conditions. However, the Plio-Pleistocene sea-level rises that fragmented the once continuous distribution, in addition to the progressive desiccation of the Lesser Sundas, may have been responsible for causing the present disjunction for approximately 800 km between Lombok and Timor. The absence of these geckos on the islands is attributed to anthropogenic changes on the landscape, particularly on Bali and Java, which have lost much of their natural vegetation. However, the apparent absence of members of the genus *Cnemaspis* on Sumatra is curious and is suspected to be the result of poor sampling of the island's herpetofauna rather than biogeographic phenomena.

KEY WORDS: *Cnemaspis gordongekkoi*, Gekkonidae, biogeography, Lombok, Indonesia.

INTRODUCTION

The Indonesian archipelago, composed of 13,677 small and large islands, is one of the richest zones on earth in terms of biodiversity Approximately 1,000 species of amphibians and reptiles are expected to occur on these islands (Collins, *et al.*, 1991). The last monograph on the reptile fauna, now in need of a revision, is the series by De Rooij (1915; 1917), show the great inadequacy of studies on this fauna.

The genus *Cnemaspis* contains 35 species (Kluge, 1991), the members of which are distinguished from other gekkonids in possessing a suite of characteristics, including rounded pupils, non-dilated, clawed digits, a distinct eyelid-like structure around the eyes and diurnal habits. Two examples of a gecko collected during a field trip to Lombok Island, Nusa Tenggara (Lesser Sunda) District, Republic of Indonesia, proved to be hitherto undescribed after comparisons with previously-described south-east Asian species of the genus (at the AMNH, BMNH, MNHN and ZRC) and the literature (e.g., De Rooij, 1915; Smith, 1925; Dring, 1979). The type series was hand-collected, photographed alive, fixed in four percent formalin and preserved in 70% ethanol, all measurements and descriptions taken of the preserved material eight to 10 months after preservation. These are here being described as a new species. Institutional abbreviations follow Leviton *et al.* (1985); geographical coordinates for the islands in the Lesser Sundas are from Anon. (1968).

Cnemaspis gordongekkoi **sp. nov. Plate 1, Fig. 1.**

Holotype.- ZRC 2.3380, collected by Indraneil Das on August 8, 1992, from the vicinity of Sendanggila Falls, *circa* 0.5 km south of Senaru village, Lombok, Nusa Tenggara District, Republic of Indonesia (8° 45'S, 116° 30'E). Gravid female. The type locality is indicated in Fig. 2.

Paratype.- ZRC 2.3381, same data as holotype. Adult male.

Diagnosis.- A large species of *Cnemaspis* (SVL to 73 mm), separable from other members of the genus by the following characteristics: absence of femoral and preanal pores, snout obtusely pointed; nostril antero-laterally directed; dorsum with large scattered tubercles from the nape backwards; ventral scales smooth and overlapping; fourth and fifth toes unequal; 22-23 scales under fourth toe; and large body size.

Description of Holotype.- Nostril antero-laterally oriented (Fig. 1.1); rostral wider than deep (rostral length/rostral depth ratio 2.62), deeply notched anteriorly by a deep groove; supranasals bordering nostrils, separated by a single scale; supralabials to below pupil nine; infralabials 10; four scales follow supralabials from below the level of the pupils to the posterior corner of the mouth; first supralabial contacting the eye; mental subtriangular (Fig. 1.2); first postmental longer than mental, shorter than the second postmental; second postmental pair separated by the first postmental pair; ear opening wider than high, as high as the first supralabial; interorbital scale rows at the midpoint of the orbit 20; canthal ridge extending backwards above the eyes; nasals and rostral contacting the nostrils (Fig. 1.2); head oviform; distinct from neck; forehead concave; snout short (head length/snout-vent length ratio 0.20), obtusely pointed; scattered warts on head and upper eyelids; small scales on snout; pupil rounded, eye with "extra-brillar fringes" (Underwood, 1954); tongue elongate, with a rounded tip, lacking a cleft.

Scutellation (of holotype, followed by paratype in parentheses): supralabials 9 (9); infralabials 10 (10); interorbital scale rows 20 (20); midbody scale rows at belly to lowest row of tubercles 30 (30); lamellae under fourth toe 22 (23).

Habitus depressed; dorsum with scattered large, rounded, non-spinose tubercles, commencing from the nape; the largest tubercles on the dorsum at midbody measuring 0.9 mm; throat and ventral scales smooth, overlapping; lateral body fold absent; mid-body scale rows across belly to below lateral row of tubercle 30; anal single; scales on palms and soles oval or elongate; femoral and preanal pores absent; tubercles on the throat, temporal region and on the sides of the vent absent.

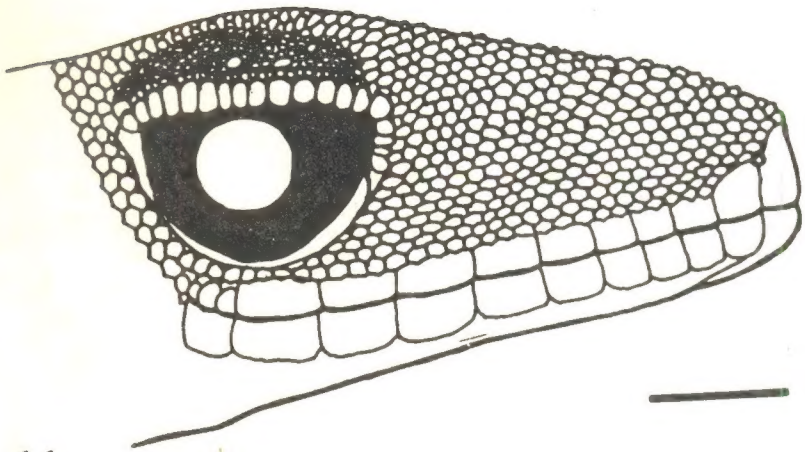
Digits slender, elongate, all clawed; subdigital scansors entire, unnotched; width of basal subdigitals less than twice adjacent scales; interdigital webs absent; fingers IV and V unequal; distal subdigital formulae: 4>3>2>5>1 (finger); 4>3>5>2>1 (toe); subdigital scansors (right limbs), 15 on finger I, 19 each on fingers II and III, 21 on finger IV, 17 on finger V; 14 on toe I, 17 on toes II, 20 on toe III, 22 on toe IV, 20 on toe V.

Tail (original, unregenerated tail) long (tail length/snout-vent length ratio 1.20), slightly flattened (tail depth/tail width ratio 0.56), not kinked at base; tubercles on the tail arranged in rows, best marked close to the tail base; subcaudal scales smooth, hexagonal, non-overlapping and not enlarged.

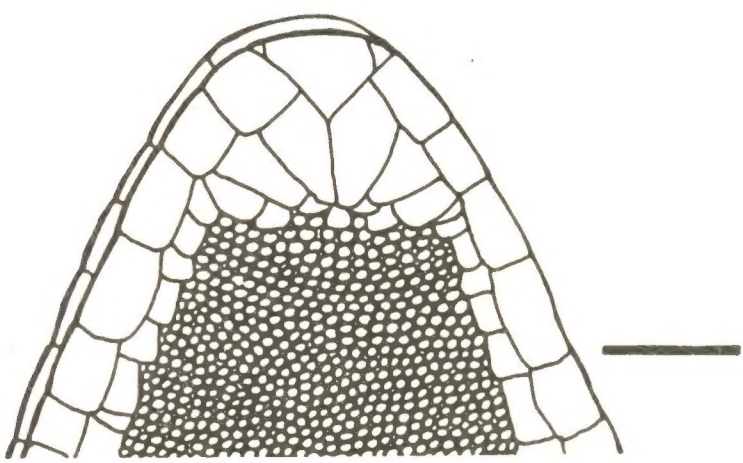
Colour in life (from Fujichrome 100 ASA slide transparencies; nomenclature after Smith, 1974; 1981): dorsum drab gray, variegated with brownish-olive and pale horn paravertebral blotches; eyelid-like structure around the eyes sulfur yellow; ventrum cream, each scale with numerous small black spots; upper surface of tail with 14 drab and olive-brown alternating bands; lower surface of tail cream (see Plate 1).

Holotype of *Cnemaspis gordongekkoi* sp. nov. (ZRC 2.3380), showing the animal in life with the tail curled over its back.
Photo: Indraneil Das. Lombok, Indonesia.

Malayan softshell turtle (*Dogania subplana*). Thailand. Photo: Indraneil Das.



1.1.



1.2.

FIGURE 1: The snout in profile (1.1) and anterior aspect of throat (1.2) of the holotype of *Cnemaspis gordongekkoi* sp. nov. (ZRC 2.3380). Markers represent 3 mm.

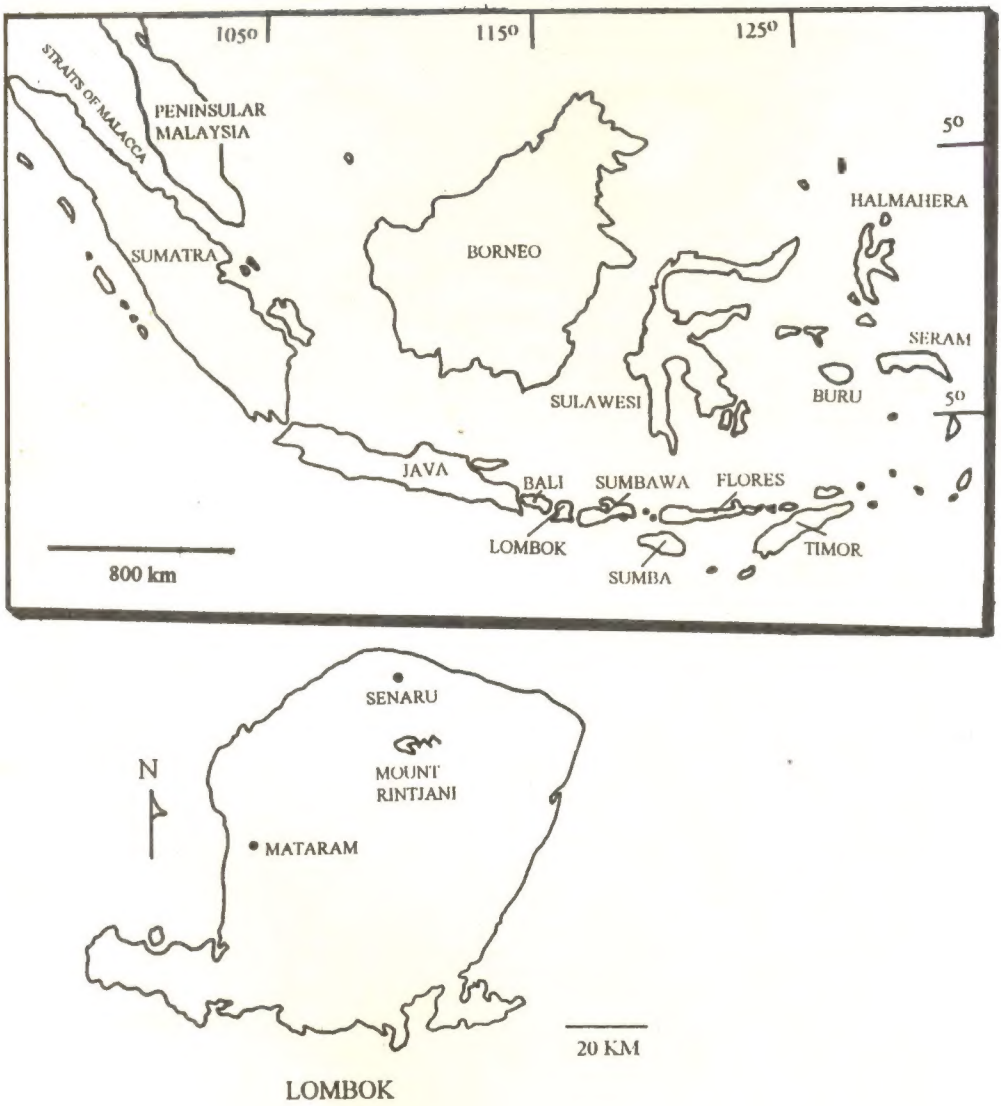


FIGURE 2: The Indonesian archipelago (excluding Irian Jaya) showing the island of Lombok (enlarged below) and the type locality of *Cnemaspis gordongekkoi* sp. nov.

Etymology.- In appreciation of the film "Wall Street" (Stone, 1987).

Measurements.- (In mm; holotype followed by paratype in parentheses): snout-vent length 73.0 (70.6); total body length 161.0 (149.6); tail length 88.0 (99.0); tail width 8.6 (7.9); tail depth 4.9 (4.9); axilla to groin distance 28.7 (33.9); head width at jaws 12.8 (12.3); head length 14.6 (13.2); head depth 5.2 (6.7); eye diameter 5.0 (5.0); eye to ear distance 6.3 (7.1); ear length 1.7 (1.4); interorbital distance 6.0 (6.2); snout-tip to eye distance 8.5 (8.2); snout-tip to nostril distance 0.8 (1.9); snout to axilla distance 27.9 (27.2); forelimb length 26.0 (24.8); hindlimb length 34.0 (31.0); tibia length 14.2 (15.0); distance between knees with femora perpendicular to body 32.0 (33.1).

COMPARISONS

In the key to the Sundaic species of *Cnemaspis* provided by De Rooij (1915), the new species falls out close to *C. timoriensis* (Duméril and Bibron, 1836) in possessing the following suite of characters: short, pointed snout; absence of femoral and preanal pores; head covered with small granules and a series of brown spots along each side of the vertebral line. The Lombok material can be easily separated from the aforementioned species in showing the following characteristics: rostral much broader than deep (versus slightly broader than deep); nine and 10 supralabials and infralabials, respectively (versus five and three supralabials and infralabials, respectively); dorsum with large, scattered tubercles (versus dorsum with small equal scales); 22-23 (versus 12) distal scales under the fourth toe; ventral scales smooth (versus imbricate) and a much larger body size: snout-vent length to 73 mm (as opposed to 35 mm in *C. timoriensis*).

The most recent identification key to the south-east Asian species of *Cnemaspis* has been given by Dring (1979), which includes species from the Malay peninsula and the Greater Sundas, but excludes the only species then known from the Lesser Sundas, *C. timoriensis* (Duméril and Bibron, 1836). In lacking femoral pores and proximal subdigital scales not larger than distal subdigital scale, it is easily differentiated from *Cnemaspis kandiana* (Kelaart, 1852), a widespread species from south-western India, Sri Lanka, the Andaman and Nicobar Islands of India and Sumatra, Sipora and Enggano, all belonging to Indonesia. These characteristics unite *C. gordongekkoi* sp. nov. to the rest of its congeneric south-east Asian species. Its smooth ventral abdominal scales differentiates the new species from *C. nigridius* (Smith, 1925), from north-western Borneo, which is further differentiated in being larger- to 85 mm- and possessing preanal pores. The new species is also easily separable from *C. kendalli* (Gray, 1845), from southern peninsular Malaysia and the nearby Pulau Tioman, Singapore, the Indonesian islands of Anamba and Natuna, and Sarawak, Malaysian Borneo, which possesses a rounded and depressed snout, unlike the short, narrow snout in *C. gordongekkoi* sp. nov. and is smaller- to 58 mm in maximum head-body length. The Lombok material also differs from the newly-described *C. argus* Dring (1979), from northern Trengganu, peninsular Malaysia, which has preanal pores (lacking in the new species), besides a smaller body size- to about 64 mm.

Cnemaspis gordongekkoi is morphologically separable from *C. boulengerii* Strauch, 1887, from Con Son, Con Dao (= Pulo Condore) and Hon Bai Can, all offshore islands in the South China Sea belonging to Vietnam, which has fewer distal subdigitals, a series of shield-like subtibial scales almost as wide as the tibia, subcaudals almost as wide as the tail and smaller maximum body size- to 66 mm. The new species is also separable from *C. affinis* (Stoliczka, 1870), from peninsular Thailand and peninsular Malaysia, which shows preanal pores and a substantially smaller maximum body size- 46.7 mm. The new species can be easily differentiated from *C. kumpoli* Taylor (1963) from Trang Province, Thailand, which has preanal pores and a smaller body size- 51 mm and *C. flavolineata* Nicholls (1949) from northern peninsular Malaysia, which also shows preanal pores, in addition to having smooth ventrals and attains a smaller size- 27.7 mm.

The new species can be recognised from both the southern population (northern Malay peninsula) of *C. siamensis* (Smith, 1925) which has one tubercle at each side of the vent, preanal pores and a snout-vent length of up to 39.7 mm; distinguished from the new Indonesian species in having preanal pores, deep and rounded mentals, ventrals heavily pigmented and smaller body size- to 46.7 mm.

TABLE 1: External characteristics of the south-east Asian species of *Cnemaspis*. Abbreviations: SVL, maximum recorded snout-vent length; ST4, distal scales under fourth toe; VS, ventral scales; FP, femoral pores; PP, preanal pores. Measurements in mm. + = presence; - = absence. "n.p." and "s.p". in the case of *C. siamensis* refer to the northern and southern populations, respectively. Further details of *Cnemaspis* species A and B can be found in Dring (1979).

Species	SVL	ST4	VS	FP	PP
Cnemaspis affinis	46.7	17-20	keeled	-	+
Cnemaspis argus	64.0	22-24	keeled	-	+
Cnemaspis boulengerii	66.0	16-18	smooth	-	-
Cnemaspis flavolineata	27.7	28	keeled	-	+
Cnemaspis gordongekkoi	73.0	22-23	smooth	-	-
Cnemaspis kandiana	35.0	11-12	smooth	+	+
Cnemaspis kendalli	58.0	18-23	keeled	-	-
Cnemaspis kumpoli	51.0	21-24	smooth	-	+
Cnemaspis nigridius	85.0	17-24	keeled	-	- or +
Cnemaspis siamensis (n.p.)	38.0	15-21	keeled	-	-
Cnemaspis siamensis (s.p.)	39.7	17-22	keeled	-	+
Cnemaspis timoriensis	35.0	12	keeled	-	-
Cnemaspis sp. A	42.0	17-19	smooth	-	+
Cnemaspis sp. B	46.7	20	keeled	-	+

and the northern population (north of the Isthmus of Kra) of the same species which typically shows two tubercles on each side of the vent, a median dark line on the throat and a smaller body size- to 38 mm.

At least two undescribed species of *Cnemaspis* remain in the region. Dring's (1979) "Species A", from northern Borneo, previously assigned to *C. siamensis* by Smith (1925), can be separated from *C. gordongekkoi* sp. nov. in having the fourth and fifth fingers subequal, presence of preanal pores and a smaller body size- to 42 mm. Dring's (1979) "Species B", known from a single specimen (FMNH 148588; not personally verified), from Labang Camp, Bintulu District, Sarawak, East Malaysia, can be

Table 1 summarises some of the diagnostic features of the south-east Asian species of *Cnemaspis*, which complements the key to the genus *Cnemaspis* for the south-east Asian species in Dring (1979). Included in the table is *C. flavolineata* Nicholls (1949), that Dring (1979) suspected to be conspecific with *C. affinis*, but considered valid by Kluge (1991).

ECOLOGICAL AND BIOGEOGRAPHIC NOTES

The two geckos were taken from unplastered brick-walls of an abandoned house between 1800-1815 hours. The collection locality is in the vicinity of the scenic Sendanggila Falls, in an area of disturbed evergreen forests. In captivity, the geckos had the curious habit of curling their

tails over the backs (Plate 1), similar to the behaviour noted in *Cnemaspis kendalli* by Lim and Lim (1992). The holotype contains a single undeveloped (uncalcified) egg in each oviduct, measuring 46 mm (left) and 56 mm (right), respectively.

Four species of gekkonid lizards (nomenclature after Kluge, 1991) have been recorded from Lombok by De Rooij (1915). These are *Cosymbotus platyurus* (Schneider, 1792) (as *Hemidactylus platyurus*), *Gekko gecko* (Linnaeus, 1768) (as *Gekko verticillatus*), *Gonydactylus marmoratus* (Gray, 1831) (as *Gymnodactylus marmoratus*) and *Hemidactylus frenatus* Duméril and Bibron, 1836. *Cnemaspis gordongekkoi* sp. nov. is therefore the first record of a *Cnemaspis* from the island of Lombok.

Among its south-east Asian congeners, *Cnemaspis timoriensis*, which appears closest morphologically to *C. gordongekkoi* sp. nov. (see "Comparisons") is also not surprisingly the nearest geographically. The distribution of members of the genus is highly disjunct, being focussed in the southern part of the Malay peninsula and the Greater Sundas (in the east) and southern India and Sri Lanka (to the west), south of 20° latitude. Several other taxa of amphibians and reptiles show similar disjunct distribution, including *Ansonia* (*fide* Inger, 1960) and *Dasia* (Inger and Brown, 1980), their absence in the intervening regions apparently due to the absence of wet evergreen forests in central and eastern peninsular India and marked seasonal climate, especially cold winters in north-eastern India, Myanmar and northern Thailand.

The distribution of species of *Cnemaspis* in the east (the Lesser Sundas) appears curious, the two species separated by straits and islands for a distance of *circa* 800 km. The apparent absence of *Cnemaspis* species on the intervening islands, including Sumbawa (8° 40'S, 118° 00'E), Sumba (10° 00'S, 120° 00'E) and Flores (8° 30'E, 121° 00'E), the islands belonging to the Maluku (formerly Moluccas) group or on the larger islands of Java and Bali cannot be attributed to inadequate study (see Brongersma, 1945; Edgar and Lilley, 1993; Kopstein, 1926; Mertens, 1928, 1957a; 1957b; Auffenberg, 1980). The south-east Asian archipelago is composed of a series of large allochthonous terranes that broke away from the northern margin of Australia during the Late Permian (Audley-Charles, 1988) or even the Early Cretaceous (Metcalfe, 1988), rafting northwards to collide with the Asian mainland. The Lesser Sundas, including Lombok, are composed of small islands that are primarily volcanic in origin (Audley-Charles, 1987; van Bemmelen, 1949). The islands in the outer arc, Sumba and Timor (8° 50'S, 126° 00'E), are primarily composed of sandstone, mudstone with igneous intrusions overlaid by limestone (Whitten and Whitten, 1992). There is little doubt that the islands of the Sunda Shelf are landbridge islands that were joined during the Quaternary glacial maxima (Morley and Flenley, 1987). Periodic inundations, during sea-level rises that marked the Plio-Pleistocene interglacial periods in the Lesser Sundan region may have caused the extinction of *Cnemaspis* by the fragmentation of once widespread continental populations that subsequently led to local extinctions on some of the islands.

Lawlor (1986) showed that the distribution of non-volant mammals are a historic consequence of extinction of relict populations on landbridge islands, where the range of formerly contiguous populations may have been fragmented by sea-level rise. However, the progressive aridity of the Lesser Sundas must have had serious effects on the biota of the islands, presumably adversely affecting species linked to mesic habitats, although disjunct, possibly relictual, distribution of the Sundaic xeric biota has also been reported (Auffenberg, 1980). A factor that may have contributed to the present disjunction in the distribution of the *Cnemaspis* geckos on these islands is the loss of moist evergreen forests as an effect of desiccation of the region.

The climate of contiguous land mass of the Sundas during the glacial maxima of the Pleistocene was essentially continental, i.e., relatively more seasonal, with semi-evergreen forests and other drier ecosystems in undisturbed areas to-

day covered with evergreen forests (Morley and Flenley, 1987). A continuous strip of savanna is thought to have existed from India to the Lesser Sundas over areas in the Indo-Malayan region that are covered by evergreen forests (Van Steenis, 1935; 1938). The seasonal climate is at present well-marked in the southern parts, especially on the Lesser Sundas, and xeric refugia may have persisted here from the Pleistocene, and even expanded in recent times. This change may have been promoted through anthropogenic change, and is supported by the disjunct, possibly relictual, distribution of the area's xeric herpetofauna as reported by Auffenberg (1980), that have close affinities with the mainland fauna.

The Lesser Sundas are the driest part of Indonesia due to the dry South Monsoons experienced during the middle parts of the year (Whitmore, 1984). With an average annual rainfall of 1,349 mm and a history of extensive deforestation and forest burning, whatever little moist evergreen forests that survive today are on mountains or in steep valleys, the typical vegetation in the archipelago being tree-less grassy hills (Bruce, 1986).

Excessive deforestation on Bali and Java (summarised by Hurst, 1990) may be a tenable reason for the absence of these largely rainforest species on the two islands, but fail to explain why no *Cnemaspis* species have been recorded from the large (473,607 sq km), relatively undisturbed and still forested island of Sumatra. Intensive field work on Sumatra, I predict, would prove the occurrence of perhaps hitherto undescribed species of *Cnemaspis* on this great island. Sumatra is separated from peninsular Malaysia, where five species belonging to the genus are known to occur, by a relatively shallow channel (the Straits of Malacca) 65 km in width.

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SEX RATIOS IN FRESHWATER TURTLES FROM JAMMU, INDIA

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ABSTRACT: The sex ratios of two freshwater turtle species, *Kachuga tecta* and *K. smithii* were studied in a lotic habitat in Jammu, northern India. In all, 36 males and 73 females of *K. tecta* and 34 males and 79 females of *K. smithii* were obtained. Because the monthly sex ratios were also biased towards females, it was thought that females dominate males in terms of numbers and in biomass in the populations under study.

KEY WORDS: Sex ratios, turtle, *Kachuga tecta*, *Kachuga smithii*, Jammu, India.

INTRODUCTION

In most natural vertebrate populations, males equal the number of females (Moll, 1979). There is evidence, however, that in certain turtles, females outnumber males by a magnitude of two to one, or even greater (e.g., Hildebrand, 1929; Risley, 1933; Cagle, 1942; Marchand, 1944; Carr, 1952; Sexton, 1959; Tinkle, 1961; Gibbons, 1970; Moll and Legler, 1971; Moll, 1979). However, almost all work on the population ecology that pertain to sex ratios are on north American species and little is on record on the sex ratios of the turtles of Asia. This study was conducted in a stream to examine sex ratios of two sympatric species of turtle, *Kachuga tecta* and *K. smithii*.

MATERIAL AND METHODS

Studies were conducted between 1989 and 1991 in Gho-Manhasan, a stream in Jammu, northern India, which lies in the drainage of the Chenab river. Turtles were collected using a variety of methods (Mosimann and Bider, 1960), such as by hand, by diving, by net and by muddling, every month, except between December and February (for *Kachuga tecta*) and November and February (for *K. smithii*), when they apparently hibernate. Upon capture, turtles were measured, and immature individuals (carapace length <56 mm) were released. Adult turtles were transferred to buckets and brought to the laboratory for other studies. Turtles were sexed using their secondary sexual characteristics (see Sahi, 1978; Gupta, 1979; Verma, 1992).

RESULTS AND DISCUSSION

Of a total of 109 specimens of *Kachuga tecta* that were collected from the Gho-Manhasan stream, 36 were males and 73 females (Table 1). The size distribution of the two sexes in the population reveals that males range in carapace length from 60-140 mm, and females from 100-180 mm. Turtles >110 mm carapace length are predominantly females. The ratios between sexually mature males and females were biased towards the latter, females outnumbering males throughout the year in the ratios 1.4-3.00 per male. The mean sex ratio for the entire year (March to November) was 2.03:1 in favour of females.

In its sympatric congener, *K. smithii*, a similar pattern is evident. A total of 113 mature specimens were collected, comprising 34 males and 79 females (Table 2). The carapace length in this species range between 56-130 mm in males and 102-219 mm in females, with turtles >110 mm usually being females. The ratio between sexually mature females and males was biased towards females, being 1.75-3.25 per male, between March and October, the mean sex ratio for the entire year being 2.32:1 in favour of females.

Workers have attributed the skewed sex ratios in turtles to sampling error (e.g., Ream and Ream, 1966; Gibbons, 1970; Gibbons and Lovich, 1990). However, recent research has shown that sex ratios could also be biased due to the effects of incubation temperature (see Pieau,

1975; Yntema, 1979; Bull, 1980; Bull and Vogt, 1979; Vogt and Bull, 1982; Yntema and Mrosovsky, 1980).

The 1:2.03 male:female ratio for *Kachuga tecta* and 1:2.32 ratio for *K. smithii* reveals a significant departure from the expected ratio of 1:1. Small sample size cannot be attributed as a factor behind this apparent anomaly, since monthly samples in both species (Tables 1 and 2) have consistently yielded a female-biased sex ratio. These overall ratios are significantly different from 1:1 ($\chi^2 = 12.56$; $P < 0.05$ in *K. tecta*; $\chi^2 = 18.56$; $P < 0.05$ in *K. smithii*).

In conclusion, in free-ranging populations of *Kachuga tecta* and *K. smithii* in Jammu, females outnumber males in every month of the year when they are active, the annual sex ratio being 2.03:1 and 2.32:1, respectively, in favour of females. Causal factors are entirely unknown, but it is possible that a sexual difference in activity and/or microhabitat use exists. Gibbons (1990) suggested that four demographic factors may influence sex ratios within a population, including sex ratios of hatchlings, differential mortality of the sexes, differential emigration and immigration rates of the sexes and differences in age in maturity of the sexes, the last considered to be

TABLE 1: Sex ratio in *Kachuga tecta* from Jammu.

Month	No of specimens	Males n (%)	Females n (%)	M:F ratio
March	16	6 (37.5)	10 (62.5)	1:1.66
April	12	5 (41.7)	7 (58.3)	1:1.40
May	11	4 (36.4)	7 (63.6)	1:1.75
June	11	3 (27.3)	8 (72.7)	1:2.66
July	13	4 (30.8)	9 (69.2)	1:2.25
August	17	5 (29.5)	12 (70.5)	1:2.40
September	10	4 (40.0)	6 (60.0)	1:1.50
October	11	3 (27.3)	8 (72.7)	1:2.66
November	8	2 (25.0)	6 (75.0)	1:3.00
Total	109	36	73	

TABLE 2: Sex ratio in *Kachuga smithii* from Jammu.

Months	No of specimens	Males n (%)	Females n (%)	M:F ratio
March	13	4 (30.8)	9 (69.2)	1:2.25
April	12	4 (33.4)	8 (66.6)	1:2.00
May	14	5 (35.8)	9 (64.2)	1:1.80
June	14	4 (28.6)	10 (71.4)	1:2.50
July	11	4 (36.4)	7 (63.6)	1:1.75
August	17	5 (29.5)	12 (70.5)	1:2.40
September	17	4 (23.6)	13 (76.4)	1:3.25
October	15	4 (26.7)	11 (73.3)	1:2.75
Total	113	34	79	1:2.32

the cause of biased adult sex ratios within many populations.

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ASPECTS OF THE FEEDING ECOLOGY OF *LISSEMYS PUNCTATA* (TESTUDINES: TRIONYCHIDAE) IN KEOLADEO NATIONAL PARK, BHARATPUR, INDIA

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(with one text-figure)

ABSTRACT: The feeding ecology of the Indian flapshell turtle, *Lissemys punctata*, was studied at Keoladeo National Park, Bharatpur, Rajasthan, India, by scat analysis. *Lissemys punctata* is an opportunistic omnivore, with a preference for animal matter. The species undergoes partial hibernation during the winter. Molluscs contribute 26%, fishes 20% and insects 20% of the food, the rest being plant food.

KEY WORDS: *Lissemys punctata*, diet, scat analysis, Bharatpur, India.

INTRODUCTION

Lissemys punctata is one of the most widespread freshwater turtles in India, being found in swamps, lakes and rivers. Despite its abundance, only basic information on its distribution and general biology are available (Smith, 1931; Daniel, 1983; Das, 1991). The behaviour and predation on this species have been studied by Auffenberg (1981) and Bhupathy and Vijayan (1989). Earlier workers (e.g., Daniel, 1983; Deraniyagala, 1939) have considered the species to be piscivorous. The present study was undertaken to determine the impact of this species on the fish population at Keoladeo National Park, Bharatpur, India, which also supports several thousand breeding piscivorous birds.

STUDY AREA

Keoladeo National Park is situated in Bharatpur, Rajasthan state, northern India. The area lies in the floodplains of the rivers Banganga and Gambir which are tributaries of the river Yamuna. Of the total area of 29 sq km, 8.5 sq km is covered by water. During the monsoons, the Park received water from the above-mentioned rivers. In summer, water-level recedes and most of the area dries up, leaving isolated shallow pools. Information on the hydrology, flora and fauna of the Park can be found in Ali and Vijayan (1986) and Vijayan (1987).

MATERIAL AND METHODS

The studies described here were conducted between June, 1989 and July, 1990. The diet of *Lissemys punctata* was studied using scat analysis (see Folkerts, 1968; Sidis and Gasith, 1985). Turtles collected from the wild were washed thoroughly and kept in a plastic tray measuring 40 x 30 x 10 cm with some water, within a cemented tank measuring 60 x 40 x 50 cm. The turtles were kept under observation for 48-72 hours and were released immediately upon defaecation. Measurements taken include curved carapace length, carapace width, plastron length, in addition to weight.

Each scat was washed in flowing water, using a sieve of mesh size 0.2 mm, and the contents separated. The percentage of each category was visually estimated. Other methods available for dietary studies of this kind include stomach content analysis by dissection (Coulter, 1957) and stomach flushing (Parmenter, 1980). The scat analysis method is advantageous over these because it does not involve sacrificing or disturbing the turtles. However, the remains of soft-bodied animals, such as insect larvae, may not be traceable in scat samples.

RESULTS AND DISCUSSION

Seventy-one specimens of *Lissemys punctata* were used in the present study, the turtles ranging

in curved carapace length from 15.0-31.9 (mean 23.59 ± SD 3.4; n = 69) cm. Mean carapace width, plastron length and weight of these turtles were 17.27 ± SD 2.2 cm, 21.52 ± SD 3.03 cm and 1.57 ± SD 0.65 kg, respectively.

Of the 71 turtles used in this study, only 41 defaecated in captivity, and as many as 12 among these defaecated twice or more. Only the first scat was included in the analysis. Time taken for the appearance of the first scat ranged between 2 to 28 (mean 21.76) hours.

Lissemys punctata appears to be an opportunistic omnivore, consuming both plant and animal matter. Animal matter was contained in 39 of 41 (95.1%) scat samples, while plants were present in 34 (82.9%). Overall, animal matter comprised an average of 67% of the food remains, by volume. Molluscs contributed 26%, fishes 20% and insects 20% of the food (Fig. 1). Scats included molluscs of the genera *Lymnaea* and *Gyrulus*, while insects represented in the scat samples include members of the orders Orthoptera (grasshoppers), Hemiptera (bugs), Coleoptera (beetles) and Hymenoptera (ants). Vertebrate food items were predominantly fishes. In one scat, a few ventral scales of an indeterminate species of snake was discovered. Remains of birds and mammals were not found. Seeds of plants such as *Nymphoides* spp., *Nymphaea* spp., *Utricularia* spp. and *Acacia nilotica* in several scats provide evidence of the consumption of parts of these plants.

TABLE 1: Food items recorded in scat samples of *Lissemys punctata* at Keoladeo National Park, Bharatpur.

Food items	Parts recorded
Plants	Stem, leaf, seed
Paspalum spp.	Stem
Echinocloa spp.	Seed
Nymphaea spp.	Seed
Nymphoides spp.	Seed
Utricularia spp.	Seed, flower
Eleocharis spp. /*Scirpus* sp.	Flower
Acacia nilotica	Seed, seedling
Animal	
Orthoptera	Appendage
Coleoptera	Elytra, appendage, larval mouthpart
Hemiptera	Appendage, wing
Hymenoptera	Head
Fish	Scale, fin, bone
Snake	Ventral scale

The presence of insects and molluscs in scat samples were not due to incidental ingestion while feeding on aquatic vegetation: in seven cases, scat samples contained only animal remains, and in 24 samples, animal matter constituted in excess of 80% of the scat, by volume (Table 2). Of the 13 records of fishes, only two had carapace length of less than 20 cm, four being from the 20-25 cm class and seven were greater than 25 cm. Of the 13 records of fishes in scat samples, 10 were during the dry season and three during the wet season.

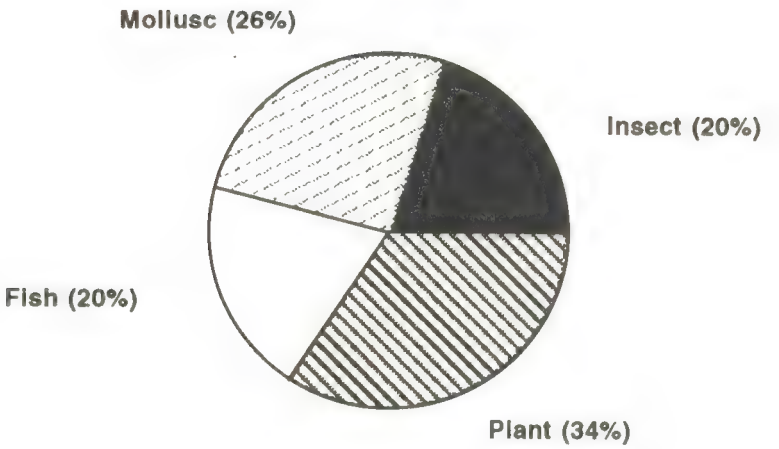

FIGURE 1: Dietary composition, based on scat analysis (volumetric estimation) of *Lissemys punctata* in Keoladeo Ghana National Park, Bharatpur (n = 41).

TABLE 2: The number of scat samples of *Lissemys punctata* in different percentage volume categories of food remains.

		Percent volume				
Food items	Present	0	1-50	51-80	81-99	100
Plant	34	7	19	5	8	2
Animal	39	2	10	5	17	7
Insect	29	12	23	0	5	1
Mollusc	27	14	18	4	5	0
Fish	13	28	5	1	5	2

The omnivorous habits of *Lissemys punctata* is well known (Smith, 1931; Daniel, 1983; Das, 1991). Tikader and Sharma (1985) mentions that this turtle is carnivorous, while Deraniyagala (1939) and Daniel (1983) even suspected it to be a pest to fish populations. The present study suggests that *L. punctata* does not seriously affect fish populations at least in the study area and indicates that fishes are mostly taken during the summer, when large numbers of dead and dying fishes are available as a result of the drying up of the waterbodies.

A total of 14 turtles were collected during the winter months (November-February) of which only two defaecated. On the other hand, during the summer and monsoons, approximately 70% of the turtles defaecated. The low number of scat samples obtained during the colder months is suspected to be due to reduced feeding and partial hibernation in the study area. Hibernation in *Lissemys punctata* in the northern parts of its range has been recorded by Smith (1931). Decrease or even cessation of feeding at low temperatures has been recorded in two North American turtles, the spotted turtle, *Clemmys guttata* (Ernst, 1976) and the slider turtle, *Trachemys scripta* (Parmenter, 1980).

The percentages of animal matter in scat samples taken during the wet (monsoon and winter) and dry seasons were 59 and 76, respectively. In the dry season, the presence of insects and fish in the scats increased by about eight and eleven percent, respectively. This is suspected to be due to greater abundance of insects and also dead and dying fishes in the shrinking water bodies, a fact already alluded to.

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AMPHIBIANS AND REPTILES RECORDED FROM THE LAMBIR HILLS NATIONAL PARK, SARAWAK, EAST MALAYSIA

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ABSTRACT : Ecological data are presented on 20 species of amphibians and reptiles collected and/or observed in the Lambir Hills National Park, Fourth Division, Sarawak, East Malaysia, during two trips made in September, 1992 and August, 1993. Some of the observations were made with the use of a tree-tower on a *Dryobalanops lanceolata* tree that allowed access 50 m above the forest floor and a tree-walk 15.65 m above ground. Seven species of amphibians and reptiles that are normally associated with human-created environments were also taken, and the total numbers of amphibians and reptiles thus recorded from the Park are 16 and 23, respectively.

KEY WORDS: Amphibians, reptiles, Lambir Hills National Park, Sarawak, East Malaysia.

INTRODUCTION

Lambir Hills National Park (4° 30'N, 113° 55'-114° 05'E) is located in the East Malaysian state of Sarawak, in north-western Borneo. The Park's centre is approximately 30 km south of the oil-town of Miri. Gazetted as a National Park in 1975, it covers an area of 6,952 hectares primarily of mixed dipterocarp forest, although there are other vegetation types occur, such as Bornean heath (*kerangas*) and scrub vegetation at the summit of Bukit Lambir. Steep slopes characterize the forest (gradients 25-30°), the altitudinal range being 30-467 m. The flora consists of about 1,500 vascular plant species (high for an exclusively lowland area). In addition, about 1,000 species of trees have been recorded from the Park, including 69 dipterocarp species (Davis, undated).

Surprisingly little is known of the fauna of the Lambir Hills. Two field trips were undertaken, on 8 September, 1992 and 4-9 August, 1993, with the intention of observing the local herpetofauna. Utilising the 40 m tree-tower constructed on a *Dryobalanops lanceolata* tree on the Pantu Trail, we made opportunistic observations on the arboreal herpetofauna, although collections were also made from other sites. A second paper on zonation and activities of flying squirrels is under preparation.

Earlier, Kiew (1984) had recorded 13 species of amphibians and 14 species of reptiles from the Park. The same paper lists a further two lizards that were identified to generic level, besides reports of the occurrence of the enigmatic Bornean earless monitor (*Lanthonotus borneensis*). Following the results in the present paper is an updated list of amphibians and reptiles now known to occur in Lambir.

Measurements were taken with dial vernier calipers (to the nearest 0.1 mm). All weights were taken with a Mettler™ AE 260 Electronic Balance (to the nearest 0.1 gm) from alcohol-preserved specimens seven to 14 days after preservation. ID/SWAK refers to the first author's field number from Sarawak, and part of the collection has been deposited at the Zoological Reference Collection (ZRC), National University of Singapore.

RESULTS

AMPHIBIANS

FAMILY: BUFONIDAE

1. Crested toad *Bufo divergens* Peters, 1871

Bufo divergens, Peters, 1871, *Monatsber. Akad. Wiss. Berlin*: 579.

Type locality: Sarawak, Malaysia.

Material: Three examples collected. ID/SWAK 16-18 (ZRC 1.3149-1.3151). All from leaves of saplings 5, 10 and 15 cm above substrate. 8 August, 1993. 2005, 2010 and 2040 hours.

Measurements: ID/SWAK 16 (adult male): Snout-vent length 20.3 mm; tibia length 9.9 mm; head width 6.2 mm; weight 0.66 gm. ID/SWAK 17 (adult male): Snout-vent length 28.3 mm; tibia length 13.1 mm; head width 8.5 mm; weight 1.39 gm. ID/SWAK 18 (adult male): Snout-vent length 32.2 mm; tibia length 14.7 mm; head width 9.2 mm; weight 3.2 gm.

Dietary information: ID/SWAK 18 contained 80 termites and two black ants. The termites belong to the subfamily Nasutitermitinae, and include both workers and soldiers. Total weight of stomach contents was 0.48 gm (15% of total body weight). ID/SWAK 17 had an empty stomach and gut. ID/SWAK 16 had an empty stomach, but its intestines bulged with presumably undigested head capsules of black ants.

The species was reported from the Park by Kiew (1984) as *Bufo biporcatus*.

FAMILY: RANIDAE

2. Green paddy frog *Rana erythraea* (Schlegel, 1837)

Hyla erythraea, Schlegel, 1837, *Abbild. Amph.*: 27.

Type locality: Java, Indonesia.

Material: None collected. Many were seen on the night of 4 August, 1993, calling from a large pond, one near human habitation, at 2100 hours and one on the forest floor, far from water, at 2230 hours.

3. Rough-sided frog *Rana glandulosa* Boulenger, 1882

Rana glandulosa, Boulenger, 1882, *Cat. Batr. Sal. Brit. Mus.*: 73.

Type locality: Sarawak, Malaysia.

Material: None collected. The call of this species, which can be syllabilised as "*wahk-wahk-wahk*", was commonly heard from a water-filled ditch at the edge of the forest during the early evenings. One specimen was caught for verification and subsequently released.

4. Greater swamp frog *Rana ingeri* Kiew, 1978

Rana ingeri, Kiew, 1978, *Mal. nat. J.*: 223.

Type locality: Sarawak, Malaysia.

Material: One example. ID/SWAK 23. Taken from the trail, at the edge of the forest. 8 August, 1993. 2210 hours. This appears to be a species of disturbed habitats.

Measurements: ID/SWAK 23 (adult female): Snout-vent length 96.2 mm; tibia length 53.4 mm; head width 36.1 mm, weight 88.2 gm.

Reproductive data: The sole specimen taken contained numerous developing eggs in both oviducts.

Dietary information: The stomach of our specimen showed remains of one large spider measuring 15.2 mm and a large beetle measuring 9.0 mm (straight length of head and thorax).

Kiew (1984) earlier collected this frog from the site.

5. Grass frog *Rana limnocharis* Boie, 1835

Rana limnocharis, Boie, *In*: Wiegmann, 1835, *Nova Acta Acad. Leop. Carol.* 17: 255.

Type locality: Java, Indonesia.

Material: One example. ID/SWAK 24. Taken from the grassy verge of road, near human habitation. 8 August, 1993. 2215 hours.

Measurements: ID/SWAK 24 (gravid female): Snout-vent length 55.7 mm; tibia length 30.2 mm; head width 17.9 mm; weight 19.5 gm.

Reproductive data: Clutch weight 2.44 gm. Relative clutch mass (clutch weight/body weight) was 0.13. Egg diameter 0.12-0.14 mm (n = 3).

FAMILY: MICROHYLIDAE

6. Bornean tree-hole toad *Metaphrynella sundana* (Peters, 1867)

Calohyla sundana, Peters, 1867, *Monatsber. Akad. Wiss. Berlin*: 35.

Type locality: Pontianak, Kalimantan, Indonesia.

Material: None collected, but the distinctive single note of the species was commonly heard at night inside the forest.

FAMILY: RHACOPHORIDAE

7. Dark-eared tree frog *Polypedates macrotis* (Boulenger, 1894)

Rhacophorus macrotis, Boulenger, 1894, *Ann. Mag. nat. Hist.*: 282.

Type locality: Baram district, Sarawak, Malaysia.

Material: One example. ID/SWAK 19. From trunk of tree, 1 m from substrate, at edge of trail. 8 August, 1993. 2045 hours.

Measurements: ID/SWAK 19 (gravid female): Snout-vent length 89.7 mm; head width 30.3 mm; tibia length 46.8 mm; weight 44.1 gm.

Reproductive data: Clutch weight 3.18 gm. Eggs were 2.1-2.4 mm (n = 3) in diameter, numbering 483. Relative clutch mass (clutch weight/female weight) was 0.07.

Kiew (1984) also found this species at Lambir.

8. File-eared tree frog *Polypedates otilophus* (Boulenger, 1893)

Rhacophorus otilophus, Boulenger, 1893, *Proc. Zool. Soc. London*: 527.

Type locality: Bongon, Sabah, Malaysia.

Material: One example. ID/SWAK 07. From trunk of tree, 1 m from substrate, at edge of trail. 4 August, 1993. 2240 hours.

Measurements: ID/SWAK 07 (gravid female): Snout-vent length 82.2 mm; head width 32.8 mm; tibia length 45.5 mm; weight 34.64 gm.

Reproductive data: Clutch weight 1.40 gm. Eggs were 2.0-2.5 mm (n = 3) in diameter, numbering 211. Relative clutch mass (clutch weight/female weight) was 0.04.

This species is listed in Kiew's (1984) checklist.

REPTILES

SQUAMATA

FAMILY: GEKKONIDAE

9. Kuhl's gliding gecko *Ptychozoon kuhli* Stejneger, 1902

Ptychozoon Kuhli, Stejneger, 1902, *Proc. Biol. Soc. Washington* 15: 37.

Type locality: North Borneo.

Material: One example. ID/SWAK 12 (ZRC 2.3387). From a *Dryobalanops lanceolata* tree, 35 m above ground. 5 August, 1993. 2055 hours. A second specimen was observed at 17 m height on the same tree, on 5 August at 2200 hours, but was not collected.

Measurements: ID/SWAK 12 (adult male): Snout-vent length 98 mm; total body length 183 mm; head width 18.2 mm; weight 15.14 gm.

Dietary data: The lizard had remains of an orthopteran in its stomach, with a 11.2 mm wing length, weighing 0.39 gm (2.58% of total body weight).

10 Flat-tailed gecko *Cosymbotus platyurus* (Schneider, 1792)

Stellio platyurus, Schneider, 1792, *Amph. Phys.* II: 30.

Type locality: Unknown.

Material: None collected. Many observed in the resthouse and the dining hall.

11. Four-clawed gecko *Gehyra mutilatus* (Wiegmann, 1835)

Hemidactylus mutilatus, Wiegmann, 1835, *Acta Acad. Leop. Carol.* 17: 238.

Type locality: Manila, Philippines.

Material: None collected. One was observed on 4 August, at 1600 hours, on the wall of the resthouse. This species occurs in primary forests as well as around human habitations.

12. Barking gecko *Gekko smithii* Gray, 1842

Gekko smithii, Gray, 1842, *Zool. Misc.*: 57.

Type locality: Penang, Malaysia.

Material: None collected or observed, but the short distinctive barks of the species was commonly heard at night in the forest.This species has reported from the site by Kiew (1984) on the basis of visual and acoustic evidence.

13. Grooved bent-toed gecko *Gonydactylus pubisulcus* (Inger, 1957)

Cyrtodactylus pubisulcus, Inger, 1957, *Sarawak Mus. J.* 8: 261.

Type locality: Mount Matang, Sarawak, Malaysia.

Material: Three examples collected. ID/SWAK 05, 21 and 22 (ZRC 2.3384-2.3386).

One was taken from the trunk of a fallen tree on 4 August, at 2050 hours, the remaining two on 8 August, from leaves of saplings, 30 and 40 cm from the substrate, at 2100 and 2107 hours, respectively.

Measurements: ID/SWAK 05 (gravid female): Snout-vent length 70 mm; total body length 146 mm; head width 12 mm; weight 5.79 gm. ID/SWAK 21 (adult male): Snout-vent length 60 mm; total body length 88 mm; head width 12 mm; weight 4.29 gm. ID/SWAK 22 (adult male): Snout-vent length 62 mm; total body length 116 mm; head width 10 mm; weight 4.12 gm.

Reproductive data: ID/SWAK 05 is a gravid female, containing two semi-calcified eggs, one in each oviduct. ID/SWAK 21 and 22 are mature males, with enlarged testes.

14. Dwarf gecko *Hemiphyllodactylus typus* Bleeker, 1860

Hemiphyllodactylus typus, Bleeker, 1860, *Nat. Tijdschr. Ned. Ind.* 20: 32.

Type locality: Agam, Sumatra, Indonesia.

Material: None collected. One was observed on a *Dryobalanops lanceolata* tree at 17 m, where it was climbing a cable, on 5 August, 1993, at 2200 hours. The attentuate appearance of this arboreal gecko is remarkable.

FAMILY: AGAMIDAE

15. Flying lizard *Draco* sp.

Material: None collected, but one was observed on 9 August, 1993, at 0910 hours, at 19.7 m height on the trunk of a dipterocarp tree. It had a yellow gular sac and a patch of green above the upperarm.

Ten species of the genus are known from Borneo (Welch *et al.*, 1990) and Inger (1983) mentioned that as many as six species may occur in sympatry at a single site on Borneo.

Kiew (1984) recorded *Draco taeniopterus* from this site.

FAMILY: SCINCIDAE

16. Blue-bellied litter skink? *Sphenomorphus cyanolaemus* Inger & Hosmer, 1965

Sphenomorphus cyanolaemus, Inger & Hosmer, 1965, *Israel J. Zool.* 14: 137.

Type locality: Sungei Seran, Labang, Bintulu District, Fourth Division, Sarawak, Malaysia.

Material: None collected, but one was observed on 5 August, 1993, on the buttress of a tree, in the shade, at 1600 hours.

Fifteen species of skinks belonging to the genus have been recorded from Borneo (Das, unpublished) and lizards of the genus *Sphenomorphus* have been recorded at Lambir by Kiew (1984).

17. Brooke's water skink? *Tropidophorus* cf. *brookei* (Gray, 1845)

Norbea brookei, Gray, 1845, *Cat. Spec. Lizards Brit. Mus.*: 102.

Type locality: Borneo.

Material: None collected, but one was observed on 8 September, 1992 at the edge of a muddy stream during the late afternoon.

The checklist of Welch *et al.* (1990) records five species of water skinks as occurring on Borneo and Kiew (1984) records the occurrence of a lizard of the genus *Norbea* at Lambir. Gray's *Norbea brookei* was put in the synonymy of the present species by Boulenger (1887).

SERPENTES

FAMILY: TYPHLOPIDAE

18. Common worm snake *Ramphotyphlops braminus* (Daudin, 1803)

Eryx braminus, Daudin, 1803, *Hist. Rep.* VII: 279.

Type locality: Vizagapatnam, India.

Material: One example. ID/SWAK 08. From the gutter, near the resthouse. 5 August, 1993. 1000 hours.

Measurements: ID/SWAK 08 (an all female, parthenogenetic species). Damaged specimen. Total body length 61 mm weight 0.12 gm.

FAMILY: COLUBRIDAE

19. Red-bellied keelback *Rhabdophis conspicillata* (Günther, 1872)

Tropidonotus conspicillatus, Günther, 1872, *Proc. Zool. Soc. London*: 596.

Type locality: Matang, Sarawak, Malaysia.

Material: One example. ID/SWAK 04 (ZRC 2.3382). From leaf litter at tree buttress. 4 August, 1993. 1820 hours.

Measurements: ID/SWAK 04: Snout-vent length 200 mm; total body length 249 mm; head width 6.6 mm; weight 3.85 gm.

Pholidosis: Midbody scale rows 19 (keeled); ventrals 137; anals 2; subcaudals 51 (divided); supralabials 8 (3-5 enter eyes); infralabials 11 (1-5 touch chin shields); postoculars 2; anterior temporals 2; posterior temporals 3.

FAMILY: VIPERIDAE

20. Wagler's pit viper *Tropidolaemus wagleri* (Boie, 1827)

Trigonocephalus Wagleri, H. Boie, *In*: F. Boie, 1827, *Isis von Oken* 20: 561.

Type locality: Sumatra, Indonesia.

Material: One example. ID/SWAK 20 (ZRC 2.3383). From sapling 30 cm above substrate, at the edge of trail. 8 August, 1993. 2050 hours.

Measurements: Snout-vent length 398 mm, total body length 478 mm, head width 164 mm; weight 28.73 gm.

Pholidosis: Midbody scale rows 23 (keeled); ventrals 144; anal 1; subcaudals 50 (divided); supralabials 9 (none touch eyes); infralabials 9 (1 and 2 touch chin shields). This species has previously been recorded from the site by Kiew (1984).

DISCUSSION

Noteworthy in our collection is the relatively large number of arboreal forms, including two species of rhacophorid frogs and five species of gekkonid lizards. Two of the geckos (*Hemiphyllodactylus typus* and *Ptychozoon kuhli*) are poorly-known, and found perhaps only because of access to the canopy afforded by the tree-tower (these may, however, lay eggs close to the ground). Six of our 20 species are generally associated with human habitation, and may be considered human commensals and/or species associated with disturbed habitats. These are *Rana erythraea*, *R. glandulosa*, *R. ingeri*, *Cosymbotus platyurus*, *Gehyra mutilatus* and *Ramphotyphlops braminus*. Of these, *Gehyra mutilatus* and *Rana ingeri* occur in undisturbed sites as well. The list of recorded species appended below is almost certainly not an exhaustive one, and many species of amphibians and reptiles await discovery, some of which, we suspect, will be new to science.

The following species of amphibians and reptiles have now been recorded for Lambir Hills National Park (after Kiew, 1984, and the present paper):

AMPHIBIANS

1. *Bufo divergens* Peters, 1871 (listed as *Bufo biporcatus* in Kiew, 1984)
2. *Pelophryne macrotis* (Boulenger, 1895)
3. *Leptobrachium hasselti* Tschudi, 1838 (listed as *Leptobrachium abbotti* in Kiew, 1984)
4. *Occidozyga laevis* (Günther, 1858)
5. *Rana chalconota* Boulenger, 1882
6. *Rana erythraea* (Schlegel, 1837)
7. Rana glandulosa Boulenger, 1882
8. *Rana ingeri* Kiew, 1978
9. *Rana kuhli* Duméril & Bibron, 1841
10. *Rana limnocharis* Boie, 1835
11. *Rana signata* (Günther, 1872)
12. *Staurois natator* (Günther, 1858)
13. *Metaphrynella sundana* (Peters, 1867)
14. *Polypedates macrotis* (Boulenger, 1894)
15. *Polypedates otilophus* (Boulenger, 1893)
16. *Rhacophorus pardalis* Günther, 1858

REPTILES

1. *Cosymbotus platyurus* (Schneider, 1792)
2. *Gehyra mutilatus* (Wiegmann, 1835)
3. *Gekko smithii* Gray, 1842
4. *Gonydactylus consobrinus* (Peters, 1871)
5. *Gonydactylus pubisulcus* (Inger, 1957)
6. *Hemiphyllodactylus typus* Bleeker, 1860
7. *Ptychozoon kuhli* Stejneger, 1902
8. *Bronchocela cristatellus* (Kuhl, 1829)
9. *Draco taeniopterus* Günther, 1861
10. *Gonocephalus borneensis* (Schlegel, 1848)
11. *Mabuya multifasciata* (Kuhl, 1820)
12. *Sphenomorphus* cf. *cyanolaemus* Inger & Hosmer, 1965
13. *Tropidophorus* cf. *brookei* (Gray, 1845)
14. *Takydromus sexlineatus* Daudin, 1802
15. *Ramphotyphlops braminus* (Daudin, 1803)
16. *Chrysopelea paradisi* Boie, 1827
17. *Dendrelaphis formosus* (Boie, 1827)
18. *Dendrelaphis pictus* (Gmelin, 1788) (listed as *Ahaetulla ahaetulla* in Kiew, 1984)
19. *Rhabdophis conspicillata* (Günther, 1872)
20. *Xenochrophis maculatus* (Edeling, 1865) (listed as *Natrix maculata* in Kiew, 1984)
21. *Bungarus fasciatus* (Schneider, 1801)

22. *Naja sumatrana* (Müller, 1887) (listed as *Naja naja* in Kiew, 1984)
23. *Tropidolaemus wagleri* (Boie, 1827)

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A CONTRIBUTION TO THE HERPETOLOGY OF BAKO NATIONAL PARK, SARAWAK, EAST MALAYSIA

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ABSTRACT: The paper lists 20 species of amphibians and reptiles recorded thus far from Bako National Park, Sarawak, East Malaysia, based on field observations, published information and material collected by the Park authorities. At present, the known herpetofauna consists of one amphibian, eight lizards and eleven snakes species. It is anticipated that the total number of species found in the area will grow considerably with sampling effort.

KEY WORDS: Amphibians, reptiles, Bako National Park, Sarawak, East Malaysia.

INTRODUCTION

Bako National Park is situated on the coast of a small peninsula 37 km north-east of Kuching, the capital of Sarawak, in East Malaysia, on the north-west coast of Borneo. Its proximity to Kuching and the ease with which large animals (e.g., bearded pig, long-tailed macaque, silvered leaf monkey, proboscis monkey and water monitor lizard) can be sighted are reasons that attract thousands of visitors to this 2,727 ha (or *circa* 27 sq km) Park annually.

The area is a mosaic of Bornean heath *(kerangas)*, lowland dipterocarp forests, mangroves and open savanna, the sea-facing sandstone cliffs with numerous small caves. Established in 1957, this is Sarawak's oldest National Park, and has an extensive system of 16 well-marked trails with colour-coded markers, totalling some 30 km. Although not extensive in terms of area (Bako is the smallest of six of Sarawak's National Parks), its plant life is unrivalled, with 25 distinct vegetation types (Strange, 1991).

Little is on record of the herpetofauna of Bako, apart from a mimeographed information sheet which lists one amphibian and nine reptiles (Anon, undated). On a brief trip to the Park between June 13-15, 1993, we compiled a list of 20 species of amphibians and reptiles based on sightings, the aforementioned information sheet and a collection made by the Park Authorities which is at the Park Headquarters at Telok Assam. Specimens in jars were given registration numbers. Further information on these and other Bornean amphibian and reptile species can be found in Inger (1966) and De Rooij (1915, 1917), respectively. The list, which follows is clearly not exhaustive, and identifies perhaps 15% of the total herpetofauna, based on lists from similar sites on northern Borneo. Hopefully, this communication will provide the impetus for fresh herpetological work at Bako and elsewhere in Sarawak.

AMPHIBIA

FAMILY: RHACOPHORIDAE

1. Four-lined tree frog *Polypedates leucomystax* (Boie, 1829)

Hyla leucomystax, Boie, *In*: Gravenhorst, 1829, *Delic. Mus. Vrat. Fasc.* 1: 26

Type locality: Java, Indonesia.

Material: Two examples (Nos. 01 and 03).

REPTILIA

SAURIA

FAMILY: GEKKONIDAE

2. Kendall's day gecko *Cnemaspis kendalli* (Gray, 1845)

Heteronota kendalli, Gray, 1845, *Cat. Spec. Lizards Brit. Mus.*: 174

Type locality: Borneo.

Material: Two examples sighted. 14 June,1993. One was photographed on the trunk of a palm tree, *circa* 2 m above ground, at 1530 hours. A second specimen was seen amongst the roots of a tree at 1535 hours. Both specimens appeared active in the shade during the day in a mixed-dipterocarp forest.

3. Spotted house gecko *Gekko monarchus* (Duméril & Bibron, 1836)

Platydactylus monarchus, Duméril & Bibron, 1836, *Erp. Gen.* 3: 335

Type locality: Ambon, Indonesia.

Material: One example sighted. 13 June,1993. Near the staircase of the parks headquarter's dining hall, at 2300 hours.

4. Asian house gecko *Hemidactylus frenatus* Duméril & Bibron, 1836

Hemidactylus frenatus, Duméril & Bibron, 1836, *Erp. Gen.* 3: 366.

Type locality: Java, Indonesia.

Material: None examined, but the species has been listed as occurring in Anon. (undated).

FAMILY: AGAMIDAE

5. Green crested lizard *Bronchocela cristatella* (Kuhl, 1829)

Agama cristatella, Kuhl, 1829, *Beitr. zur Zool. Verh. Anat.* 1: 108

Type locality: "Patria?". Not located in maps consulted.

Material: None examined but listed in Anon (undated).

6. Common flying lizard *Draco volans* Linneaus, 17566

Draco volans, Linnaeus, 1766, *Syst. Nat.* 1: 358

Type locality: Java, Indonesia.

Material: None examined, but listed in Anon (undated).

FAMILY: SCINCIDAE

7. Common tree skink *Apterygodon vittatum* Edeling, 1865

Apterygodon vittatum, Edeling, 1865, *Nedel. Tijdschr. Dierk.* 2: 201

Type locality: Borneo.

Material: One example sighted. 14 June, 1993. On tree a trunk, in the shade, at 1100 hours. The species has been previously recorded from Bako (as *Dasia vittata*) by Payne (1990).

8. Common sun skink *Mabuya multifasciatus* (Kuhl, 1820)

Scincus multifasciatus, Kuhl, 1820, *Beitr. Zool.*: 126.

Type locality: Java, Indonesia.

Material: One example sighted. 15 June 1993. The specimen was seen basking on rotting palm bark *circa* 0.5 m from the ground at 0930 hours near the rest house.

FAMILY: VARANIDAE

9. Water monitor *Varanus salvator* (Laurenti, 1768)

Stellio salvator, Laurenti, 1768, *Syn. Rep.*: 56

Type locality: "America" (in error).

Material: Two specimens sighted. 14 June, 1993. One, approximately 1.5 m in total body length, near the dining hall at 0930 hours, where it was probably scavenging for food leftovers. 15 June, 1993. One, approximately 2 m, this specimen was sighted at the edge of a secondary forest near the rest house at 0930 hours, where it appeared to be basking. A third specimen was found in a large jar in the Parks's collection that is unnumbered.

SERPENTES

FAMILY: BOIDAE

10. Reticulated python *Python reticulata* (Schneider, 1801)

Boa reticulata, Schneider, 1801, *Hist. Amph.* 2: 264

Type locality: Unknown.

Material: None examined. The species has been listed as occurring in the Park (Anon., undated).

FAMILY: COLUBRIDAE

11. Oriental whip snake *Ahaetulla prasinus* (Reinwardt, 1827)

Dryophis prasinus, Reinwardt, *In*: Boie, 1827, *Isis von Oken* 20: 545

Type locality: Java, Indonesia.

Material: One example (No. 05).

12. Mangrove cat snake *Boiga dendrophila* (Boie, 1827)

Dipsas dendrophila, Boie, 1827, *Isis*: 549

Type locality: Java, Indonesia.

Material: One example (unnumbered).

13. Paradise flying snake *Chrysopelea paradisi* Boie, 1827

Chrysopelea paradisi, Boie, *In:* Boie, 1827, *Isis*: 547.

Type locality: Java, Indonesia.

Material: Three examples (Nos. 02, 08 & 10).

14. Twin-barred flying snake *Chrysopelea pelias* (Linnaeus, 1758)

Coluber pelias, Linnaeus, 1758, *Syst. Nat. 10th edn.*: 224

Type locality: "Indiis".

Material: One example (No. 11).

15. Striped bronzeback tree snake *Dendrelaphis caudolineata* (Gray, 1834)

Ahaetulla caudolineata, Gray, 1834, *Ill. Ind. Zool.* 2: 81

Type locality: Malay peninsula.

Material: One example (No. 04).

16. Common Malayan racer *Elaphe flavolineata* (Schlegel, 1837)

Coluber flavolineata, Schlegel, 1837, *Phys. Serp.* II: 14

Type locality: Java, Indonesia.

Material: One example (unnumbered).

17. Spotted keelback *Xenochrophis maculata* (Edeling, 1865)

Tropidonotus maculatus, Edeling, 1865, *Nederl. Tijdschr. Dierk.* II: 203

Type locality: Martapura, near Bandjermasin, Kalimantan, Indonesia.

Material: One example (No. 07).

FAMILY: ELAPIDAE

18. Black cobra *Naja sumatrana* (Müller, 1890)

Naja tripudians var. *sumatrana*, Müller, 1890, *Verh. Natur. Ges. Basel* 8: 277

Type locality: Solok (Sumatra), Tadjong Morawa (not located in maps consulted) and Java, Indonesia.

Material: One example (unnumbered).

FAMILY: HYDROPHIIDAE

19. Yellow-lipped sea krait *Laticauda colubrinus* (Schneider, 1799)

Hydrus colubrinus, Schneider, 1799, *Hist. Amph.* 1: 238

Type locality: Unknown.

Material: One example (unnumbered). This is the first record of the species from Sarawak, previous reports from Borneo being from Sabah (Stuebing, 1991) and Brunei Darussalam (Das, 1992). The species is suspected to be widespread in Borneo, the paucity of records in the literature probably reflecting inadequate attention given to sea snakes in the region.

FAMILY: VIPERIDAE

20. Wagler's pit viper *Tropidolaemus wagleri* (Boie, 1827)

Trigonocephalus Wagleri, H. Boie, *In*: F. Boie, 1827, *Isis von Oken* 20: 561

Type locality: Sumatra, Indonesia.

Material: One example (No. 06).

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THE DISTRIBUTION OF AMPHIBIANS IN GUJARAT STATE, INDIA

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(with two text-figures)

ABSTRACT: The paper reports a collection of amphibians made from the state of Gujarat, in western India. A total of fifteen species, representing four families were found, including four species, *Rana keralensis*, *Kaloula pulchra*, *Microhyla rubra* and *Polypedates maculatus*, that are being reported for the first time from the state.

KEY WORDS: Amphibian, anuran, zoogeography, Gujarat, India.

INTRODUCTION

The amphibians of Gujarat have been greatly neglected even in the fundamental works on Indian amphibians of Boulenger (1890; 1920) and a few retrospective studies by the Bombay Natural History Society (e.g., McCann, 1938; Soman, 1960; Daniel and Shull, 1963) have provided short accounts of the amphibian fauna of Kutch and Surat Dangs. The first review of the amphibians of Gujarat was published by Sarkar (1984) in which nine species of anurans were dealt with, based on the material in the collection in the Zoological Survey of India.

As a result of our studies, spanning about eight years, 15 species of anurans belonging to seven genera and four families have been verified from Gujarat. Most of these species were recorded from the Shoolpaneshwar Wildlife Sanctuary, which is part of Rajpipla Forest Division, Bharuch District, situated on the left bank of the Narmada river. The recorded species include eight out of nine species reported by Sarkar (1984). Two more species, *Uperodon systoma* (Naik, 1984) and *Rana malabarica* (Naik and Patel, 1986) have been reported in addition to the species in the aforementioned work. Recently, we have recorded five more species from various parts of Gujarat: *Rana keralensis*, *Kaloula pulchra*, *Uperodon globulosus*, *Microhyla rubra* and *Polypedates maculatus*.

THE PHYSIOGRAPHIC UNITS WITHIN GUJARAT

Localities within Gujarat state from where amphibians have been recorded by earlier workers and during the present work have been given in Table 1.

The state of Gujarat lies in western India. Climatically, the state can be divided into six regions (Figure 1):

1. South Gujarat (between Bharuch and Vapi),
2. Central Gujarat (between Bharuch and Ahmedabad),
3. Ahmedabad and adjacent areas,
4. North Gujarat (including the districts of Banaskantha, Sabarkantha, Gandhinagar and Mehsana),
5. Saurashtra, and
6. Kutch.

The north-western boundary of Gujarat is occupied by the deserts of Kutch that border Rajasthan. The north Gujarat region is arid or semi-arid, and both north Gujarat and Saurashtra exhibits dry tropical and thorny vegetation, while central Gujarat and the region north of the Vindhyas show dry tropical deciduous vegetation. To the south of the Narmada, the vegetation is mostly moist tropical, as a result of its proximity to the Western Ghats region (Fig. 2).

SPECIES LIST FROM GUJARAT STATE

Fifteen species of amphibians have been verified by us from Gujarat (Table 2).

We did not find *Bufo viridis*, which was reported by Sarkar (1984). Our list includes seven species which were not dealt with in the afore-

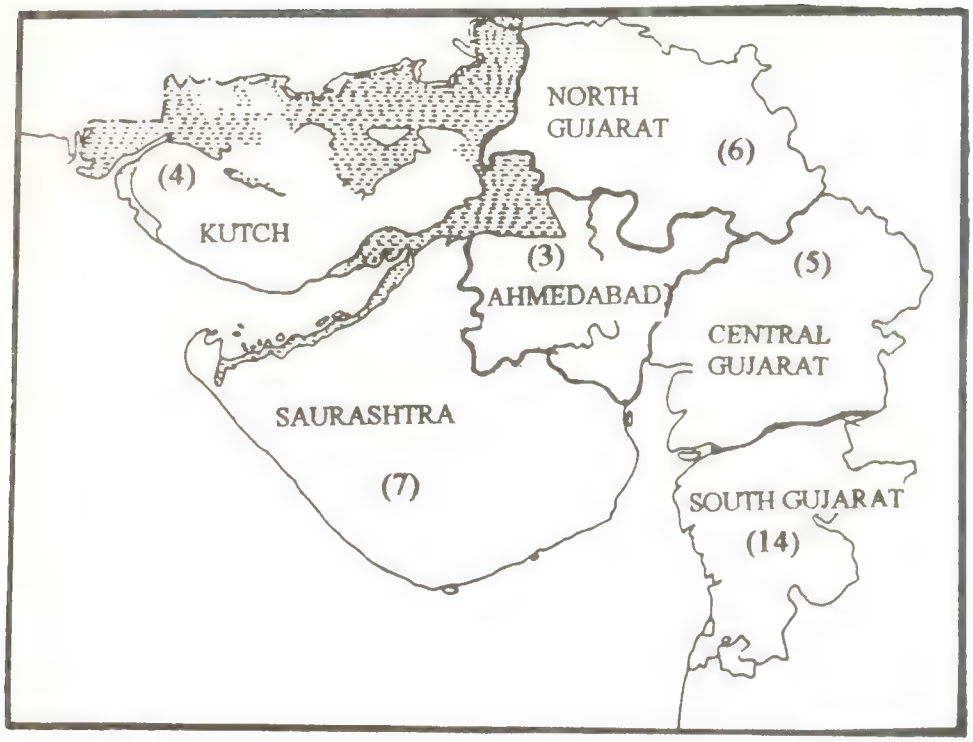

FIGURE 1: Distribution of amphibians in Gujarat. Numbers in parentheses are total species recorded from each district.

mentioned work, the distribution of which have been dealt with below:

Kaloula pulchra: Two examples were collected, one from near Mal-Samot village, Shoolpaneshwar Sanctuary (Naik *et al.*, 1992), the other from Panchmahal District of northern Gujarat by R. Vyas. Both were collected during the rains from tree-trunks. This beautiful microhylid is being reported from Gujarat for the first time.

Microhyla rubra: This microhylid appears to be rare in Gujarat, being collected from a single locality- the Sagai forest of Shoolpaneshwar Sanctuary. One was found resting under a stone during the day.

Uperodon globulosus: Four examples were collected from sites within the Shoolpaneshwar Sanctuary (from Piplod, Mosda and Sagai), from small stream beds, where they were buried less than half a metre beneath the soil surface. The soil in the region is composed of loose sand and soft gravel, and therefore with a high water-retaining capacity. All frogs were found near termitaria. The occurrence of the species in the Dangs was reported by Daniel (1963).

Uperodon systoma: The presence of this species was reported by Naik (1984). One specimen was collected from a dried tributary of the river Vishwamitri, which passes through the University of Baroda campus.

Polypedates maculatus: The species is the sole representative of the family Rhacophoridae in the state of Gujarat. Two examples have been recorded from Surat and Bulsar and five from Sagai and Piplod areas of Shoolpaneshwar Sanctuary.

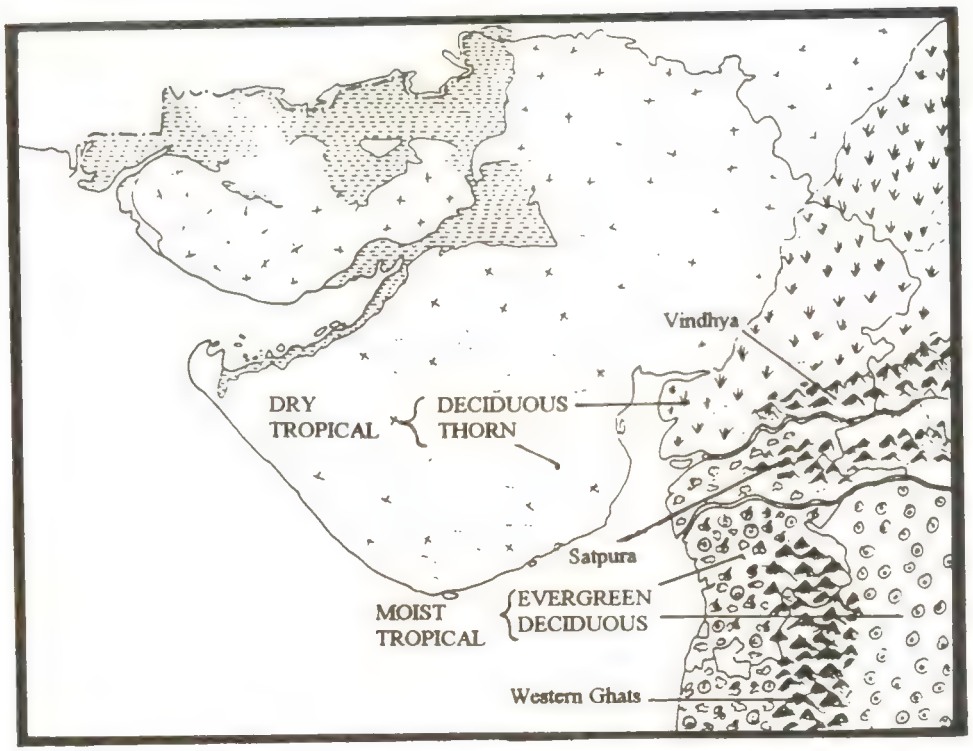

FIGURE 2: Vegetational zones in Gujarat.

Rana malabarica: The occurrence of this frog in Gujarat was reported by Naik and Patel (1986). The species was found in Navsari, a town in south Gujarat.

Rana keralensis: We collected three examples of this species during the day from the rivulet that passes through the forested areas of Shoolpaneshwar Sanctuary (Sagai and Mosda). This little-known species was, until recently, considered an endemic of Kerala and Tamil Nadu, but Daniels (1992) has shown that the range of the species extends further north, through Karnataka to Maharashtra. Our studies reveal that the range of this species extends at least to the left bank of the Narmada river in Gujarat state (Naik and Vinod, in press).

UNCERTAIN DISTRIBUTION RECORDS

Besides *Bufo viridis*, two species of amphibians that were reported by earlier workers are not represented in our collection. *Rana leithii*, listed as occurring in the state by Inger and Dutta (1986) could not be located during our investigations. Daniel (1963) reported on the occurrence of an apodan, *Ichthyophis bombayensis* from Waghai in the Surat Dangs. We have explored the area but could not find this species.

SPECIES DIVERSITY AND GEOGRAPHICAL CORRELATES

The studies reveal that the distribution of amphibians within the state of Gujarat is non-uniform (Fig. 1 and Table 3). Region 1 is rich in amphibian species diversity, south Gujarat supporting at least 14 species of anuran amphibian species. A majority of these are found in the Shoolpaneshwar Sanctuary. The central Gujarat region has six species, while the Ahmedabad region and its surroundings and Kutch appear to be impoverished, with only three and four species, respectively.

TABLE 1: The status of knowledge on the distribution of amphibians in Gujarat state. References to the collections by the Bombay Natural History Society (BNHS) and Zoological Survey of India (ZSI) are in the text.

Family and species	Collection locality (BNHS and ZSI)	Collection locality (the present study)
RANIDAE		
Rana cyanophlyctis	Palanpur, Deesa, Rajkot, Viramgham, Dhangadhra, Godhra, Veraval, Jamnagar	Recorded from all districts
Rana tigerina	Bhuj, Anjar, Mehsana, Veraval, Rajkot	Recorded from all districts
Rana limnocharis	Bhuj, Mehsana, Rajkot, Dwarka, Jasdan, Veraval, Godhra	Surat, Navsari, Bulsar, Baroda, Savli, Sagai, Chota-Udaipur, Mal-Samot, Rajpipla
Rana hexadactyla	Halwad, Jamnagar	Surat, Navsari, Bulsar, Dangs, Bharuch
Rana keralensis	Not reported	Sagai, Mosda
Rana malabarica	Not reported	Navsari
Tomopterna breviceps	Vijarkhi, Jamnagar	Sagai, Namgir, Mosda, Piplod, Jamnagar
RHACOPHORIDAE		
Polypedates maculatus	Not reported	Sanki, Bulsar, Sagai
MICROHYLIDAE		
Kaloula pulchra	Not reported	Panchmahal, Mal-Samot
Uperodon globulosus	Dangs	Sagai, Piplod, Mosda
Uperodon systoma	Not reported	Baroda
Microhyla ornata	Palanpur, Bhuj	Mosda, Sagai, Namgir, Panchmahal
Microhyla rubra	Not reported	Sagai
BUFONIDAE		
Bufo melanostictus	Vijarkhi, Jamnagar, Ranavav, Somnath, Girnar, Junagadh, Rajkot, Veraval	Reported from all districts
Bufo stomaticus	Palanpur, Bhuj	Navsari, Baroda, Bharuch, Valsad, Kutch

The high diversity of the amphibian fauna of south Gujarat can be attributed to the physiography and vegetation of the region. The Narmada river flows between the Vindhya and Satpura ranges, dividing the area into a northern continental and a southern peninsular regions. Floristically, south Gujarat, which is situated south of the Narmada river, belongs to the west (Malabar) coast. Kutch and most of Saurashtra within the continental region is part of the Indus plains, while central Gujarat and a large part of north Gujarat belongs to central India. The region south of the Satpuras ranging up to the Narmada river is part of the Deccan plateau. The soil,

TABLE 2: Amphibians recorded from Gujarat, India.

ORDER: ANURA

FAMILY: RANIDAE

1. *Rana cyanophlyctis* (Schneider, 1799)
2. *Rana hexadactyla* (Lesson, 1834)
3. *Rana keralensis* (Dubois, 1980)
4. *Rana limnocharis* (Gravenhorst, 1829)
5. *Rana malabarica* Tschudi, 1838
6. *Rana tigerina* (Daudin, 1802)
7. *Tomopterna breviceps* (Schneider, 1799)

FAMILY: RHACOPHORIDAE

8. *Polypedates maculatus* (Gray, 1834)

FAMILY: MICROHYLIDAE

9. *Kaloula pulchra* Gray, 1831
10. *Microhyla ornata* (Duméril and Bibron, 1841)
11. *Microhyla rubra* Jerdon, 1854
12. *Uperodon globulosus* (Günther, 1854)
13. *Uperodon systoma* (Schneider, 1799)

FAMILY: BUFONIDAE

14. *Bufo melanostictus* Schneider, 1799
15. *Bufo stomaticus* Lütken, 1862

climate, vegetation and flora of the continental region are different from the rain-fed evergreen forests of the Western Ghats of the peninsular region. The biota of the Malabar region is abundantly represented in the south Gujarat region, and among the amphibian fauna, the best representative of the Western Ghats species here is perhaps *Rana keralensis*. In summary, the ranges of many Western Ghats species extend up to the Narmada region, which has the highest amphibian diversity within the state of Gujarat.

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The faunal surveys of the Narmada Valley was carried out under the project on the eco-environmental and wildlife management studies on the Sardar Sarovar submergence area in Gujarat, sponsored by SSNNL. YMN was associated with the Frog Census Project of the Ministry of Commerce, Government of India. The help rendered by Prof. Bonny Pilo, Head, Department of Zoology, M. S. University and Raju Vyas, Assistant Curator, Sayaji Baug Zoo, is gratefully acknowledged. Finally, we would like to thank A.

TABLE 3: Presence (+) or absence (-) of anuran amphibians in the eight physiographic units within Gujarat. Abbreviations are as follows: SG, South Gujarat; CG, Central Gujarat; AHM, Ahmedabad and adjacent areas; SAU, Saurashtra; NG, North Gujarat; KUT, Kutch.

Species	SG	CG	AHM	SAU	NG	KUT
RANIDAE						
Rana cyanophlyctis	+	+	+	+	+	+
Rana hexadactyla	+	-	-	-	+	-
Rana tigerina	+	+	+	+	+	+
Rana keralensis	+	-	-	-	-	-
Rana limnocharis	+	-	-	+	+	-
Rana malabarica	+	-	-	-	-	-
Tomopterna breviceps	+	-	-	+	-	-
RHACOPHORIDAE						
Polypedates maculatus	+	-	-	+	-	-
MICROHYLIDAE						
Kaloula pulchra	+	-	-	-	-	-
Microhyla ornata	+	-	-	+	-	-
Microhyla rubra	+	-	-	-	-	-
Uperodon globulosus	+	-	-	-	-	-
Uperodon systoma	-	+	-	-	-	-
BUFONIDAE						
Bufo melanostictus	+	+	+	+	+	+
Bufo stomaticus	+	+	-	+	+	+

K. Sarkar of the Zoological Survey of India for his help in the identification of some of the anurans.

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Navsari (Gujarat State). *J. Bombay nat. Hist. Soc.* 83: 672.

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A CHECKLIST AND KEY TO THE GEKKONID LIZARDS OF PAKISTAN

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ABSTRACT: A checklist and dichotomous key for the identification of lizards belonging to the family Gekkonidae from Pakistan is presented. The fauna is at present known to comprise 34 species in 12 genera.

KEY WORDS: Gekkonidae, taxonomy, checklist, identification key, Pakistan.

INTRODUCTION

Since the publication of the monograph of gekkonid lizards of the former USSR and adjacent countries by Szczerbak and Golubev (1986; see Khan, 1991a, for a discussion), several new geckos have been added to the fauna of Pakistan (Khan, 1980; 1988; 1991a; 1992; 1993a; 1993b; Khan and Baig, 1992; Khan and Tasnim, 1990). Additionally, recent collections from northern Pakistan have shown that *Tenuidactylus stoliczkai* and *T. fedtschenkoi* do not belong to the Pakistani fauna (Khan, 1991a; Khan and Baig, 1992) and *Tenuidactylus walli*, which was long placed in the synonymy of *T. stoliczkai* and *T. chitralensis* is a valid species and conspecific with the latter (Khan, 1992).

Within Pakistan, the family Gekkonidae is represented by 34 species in 12 genera. The following checklist and key was prepared to both update our knowledge of the geckos of Pakistan and to aid in their identification. Additionally, it is to remind Indian colleagues of an earlier request (Khan, 1991b) for help in delimiting ranges of some of these species which have been recorded close to the Indian border.

CHECKLIST OF PAKISTANI GEKKONID LIZARDS

Agamura femoralis M. Smith, 1933

Agamura femoralis, M. Smith, 1933, *Rec. Indian Mus.* 35: 17.

Type locality: Kharan, Balochistan, Pakistan.

Distribution: Recorded from Kharan and Chagi Deserts, from close to rocky outcrops.

Agamura persica (A. Duméril, 1856)

Gymnodactylus persicus, A. Duméril, 1856, *Arch. Mus. Hist. nat., Paris* 8: 481.

Type locality: Persia.

Distribution: Reported from Iran eastwards to the vicinity of Karachi and northwards to the Waziristan hills, between 25-100 m above msl.

Alsophylax tuberculatus (Blanford, 1874)

Bunopus tuberculatus, Blanford, 1874, *Ann. Mag. nat. Hist.* (4) 13: 454.

Type locality: Persian Balochistan.

Distribution: Ranges from Syria, through eastern Arabia, Iraq, southern Iran, southern Afghanistan to Pakistan, where it is common in Balochistan, southern Sindh, Las Belas and around Hyderabad, below 2,000 m above msl.

Crossobamon lumsdenii (Boulenger, 1887)

Stenodactylus lumsdenii, Boulenger, 1887, *Cat. Lizards Brit. Mus.*, 3: 479.

Type locality: Between Nushki and Helmand.

Distribution: Recorded only from the type localities, in northern Balochistan, Pakistan.

Crossobamon maynardi (M. A. Smith, 1933)
Stenodactylus maynardi, M. A. Smith, 1933, *Rec. Indian Mus.* 35: 18.

Type locality: Balochistan, near the Afghanistan border.

Distribution: Collected from north-western Balochistan, Pakistan.

Crossobamon orientalis (Blanford, 1876)
Stenodactylus orientalis, Blanford, 1876, *J. Asiatic Soc. Bengal* (2) 45: 21.

Type locality: Rohri and Shikarpur Districts, Upper Sindh, Pakistan.

Distribution: Distributed throughout Thar, Cholistan and Thal Deserts of Pakistan. There are no records from Balochistan. It has been recorded from Rajasthan, in India by Biswas and Sanyal (1977) and Sharma and Vazirani (1977).

Cyrtodactylus battalensis Khan, 1993
Cyrtodactylus battalensis, Khan, 1993, *Pakistan J. Zool.* 25: 67.

Type locality: Vicinity of Batgram, Manshera, NWFP, Pakistan.

Distribution: Known only from the type locality.

Cyrtodactylus dattanensis (Khan, 1980)
Gymnodactylus dattanensis, Khan, 1980, *Pakistan J. Zool.* 12: 11-16.

Type locality: Datta, Manshera, NWFP, Pakistan.

Distribution: Widely distributed in alpine Punjab and eastern NWFP, Pakistan.

Cyrtodactylus mintoni (Golubev & Szczerbak, 1981)
Gymnodactylus mintoni, Golubev & Szczerbak, 1981, *Faun. Syst.*: 40.

Type locality: Udigram, Swat, NWFP, Pakistan.

Distribution: Known only from the type locality.

Cyrtopodion kachhensis (Stoliczka, 1872)
Gymnodactylus kachhensis, Stoliczka, 1872, *Proc. Asiatic. Soc. Bengal* (1): 79.

Type locality: Kutch, south-western Sindh, Pakistan.

Distribution: Distributed over most of Kutch, coastal Sindh and Las Bela, Pakistan.

Cyrtopodion scaber (Heyden, 1827)
Stenodactylus scaber, Heyden, *In*: Rüppell, 1827, *Atlas N. Afr. Rept.*: 15.

Type locality: Arabia.

Distribution: Ranges from Egypt to Rajputana, in India. In Pakistan, it has been reported from upper and lower Indus Valley, along the eastern edge of the Thar Desert. It is also known from Balochistan. Biswas and Sanyal (1977) and Sharma and Vazirani (1977) have reported the species from Rajasthan State, India.

Cyrtopodion watsoni (Murray, 1892)
Gymnodactylus watsoni, Murray, 1892, *Zool. Beluch.*: 68.

Type locality: Quetta, Balochistan, Pakistan.

Distribution: Recorded from Salt Range, Punjab, Manshera, NWFP and Quetta, Balochistan, Pakistan.

Eublepharis macularius (Blyth, 1855)
Cyrtodactylus macularius, Blyth, 1855, *J. Asiatic Soc. Bengal* 23: 737-738.

Type locality: Salt Range, Punjab, Pakistan.

Distribution: Ranges from southern Transcaspia, through Iraq to Pakistan and onto Rajputana and Khandesh in India. In Pakistan, it has

been recorded NWFP, northern Punjab, Balochistan and Lower Sindh. It also occurs in Kashmir.

Hemidactylus brookii Gray, 1845

Hemidactylus brookii, Gray, 1845, *Cat. Lizards Brit. Mus.*: 153.

Type locality: Borneo.

Distribution: Widespread in tropical and subtropical Asia and northern Africa. It has also been reported from the West Indies. In Pakistan, it is common in the plains, avoiding the higher mountains of the north and extends to the peripheral humid areas around deserts and oases.

Hemidactylus flaviviridis Rüppell, 1835

Hemidactylus flaviviridis, Rüppell, 1835, *Neue Wirb. Faun. Abyss.*: 18.

Type locality: Massaua Islands, Eritrea.

Distribution: Widespread in temperate Asia, from the Red Sea to the coasts of Arabia and Iran, across Pakistan and northern India up to Bangladesh. In Pakistan, it is reported from the plains below 1,000 m and is always associated with man.

Hemidactylus frenatus Schlegel, 1836

Hemidactylus frenatus, Schlegel, *In*: Duméril & Bibron, 1836, *Erp. Gen.* 3: 366.

Type locality: Java.

Distribution: Widespread throughout the world. In Pakistan, it has been collected from the lower Indus Delta and Punjab.

Hemidactylus leschenaultii Duméril & Bibron, 1836

Hemidactylus leschenaultii, Duméril & Bibron, 1836, *Erp. Gen.* 3: 364.

Type locality: Sri Lanka.

Distribution: Extends from eastern and southern India, as well as Bangladesh, to lower Sindh, where it has been recorded from the lower Indus Delta.

Hemidactylus persicus Anderson, 1872

Hemidactylus persicus, Anderson, 1872, *Proc. Zool. Soc.* 1872: 378.

Type locality: Shiraz, Iran.

Distribution: Extends from eastern Arabia, through southern Iran to Pakistan, where it has been recorded from Balochistan, Sindh, Waziristan, southern Potwar Plateau, in central Punjab.

Hemidactylus triedrus Daudin, 1802

Hemidactylus triedrus, Daudin, 1802, *Hist. Nat. Rept.*: 155.

Type locality: Unknown.

Distribution: Range includes eastern Pakistan, peninsular India and Sri Lanka. In Pakistan, it occurs in coastal areas of lower Indus Delta.

Hemidactylus turcicus (Linnaeus, 1758)

Lacerta turcica, Linnaeus, 1758, *Syst. Nat. 10th edn.* 1: 202.

Type locality: Asiatic Turkey.

Distribution: Ranges from northern Africa and the Mediterranean region, through the Middle East, to Iran, Afghanistan and Pakistan, where it is known from coastal Sindh. It is also known from the West Indies, eastern Mexico, southern United States, where it has been introduced.

Ptyodactylus homolepis Blanford, 1876

Ptyodactylus homolepis, Blanford, 1876, *J. Asiatic. Soc. Bengal* 45(2): 19.

Type locality: Mahar Division, Shikarpur District, north-western Sindh, Pakistan.

Distribution: Known only from type locality.

Tenuidactylus baturensis Khan & Baig, 1992
Tenuidactylus baturensis, Khan & Baig, 1992, *Pakistan J. Zool.* 24(4): 273.

Type locality: Passu and Khaiber, Gilgit Agency, Pakistan.

Distribution: Known only from type localities.

Tenuidactylus fortmunroi Khan, 1993
Tenuidactylus fortmunroi, Khan, 1993, *Pakistan J. Zool.* 25: 217.

Type locality: Khar Gardens and Fort Munro, Dera Ghazi Khan District, western Punjab, Pakistan.

Distribution: Known only from type localities.

Tenuidactylus indusoani (Khan, 1988)
Cyrtodactylus indusoani, Khan, 1988, *J. Herpetol.* 22: 241.

Type locality: Pirpeahai, Iskinderabad, Mianwali District, north-western Pakistan.

Distribution: Known only from type localities.

Tenuidactylus kohsulaimanai Khan, 1991
Tenuidactylus kohsulaimanai, Khan, 1991, *J. Herpetol.* 25: 199.

Type locality: Sakhisarwar village, Dera Ghazi Khan District, north-western Punjab, Pakistan.

Distribution: Besides the type locality, this species is known from Rakhi Gorge, along Dera Ghazi Khan-Fort Munro Road.

Tenuidactylus montiumsalsorum (Annandale, 1913)
Gymnodactylus montiumsalsorum, Annandale, 1913, *Rec. Indian Mus.* 9: 309.

Type locality: Salt Range, Punjab, Pakistan.

Distribution: Known from various localities along the southern Salt Range, Punjab, Pakistan.

Tenuidactylus rohtasfortai Khan & Tasnim, 1990
Tenuidactylus rohtasfortai, Khan & Tasnim, 1990, *Herpetologica* 46: 142.

Type locality: Ahmadyyah Mosque, Goi-Madan, Kotli, Kashmir.

Distribution: Widely distributed in alpine Punjab and south-eastern Kashmir. In the Potwar Plains, it extends through the hills areas around Jhelum up to Islamabad.

Tenuidactylus walli (Ingoldby, 1922)
Gymnodactylus walli, Ingoldby, 1922, *J. Bombay nat. Hist. Soc.* 28: 1051.

Type locality: Drosh Fort, Chitral, NWFP, Pakistan.

Distribution: Besides the type locality, this species has been collected from Karakal village in Bumhoet valley and Ghariet village in Chitral, NWFP.

Teratoscincus microlepis Nikolsky, 1900
Teratoscincus microlepis, Nikolsky, 1900, *Ann. Mus. Zool. Acad. Sci. St. Petersburg* 4: 145.

Type locality: Duz Abad, E. Kerman, Iran.

Distribution: The species extends from Dasht-i-Lut, near Kirman, Iran, eastwards to Nushki and Kharan in Balochistan, Pakistan.

Teratoscincus scincus (Schlegel, 1858)
Teratoscincus scincus, Schlegel, 1858, *Handl. Beoefening Dierkunde* 2: 16.

Type locality: Ili river, Turkestan.

Distribution: Ranges from the shores of the Caspian Sea through Tadjikistan and Balochistan, Pakistan.

Teratolepis fasciata (Blyth, 1854)

Homonota fasciata, Blyth *In*: Jerdon, 1854, *J. Asiatic Soc. Bengal* 22: 468.

Type locality: Jaulna, Hyderabad province, India.

Distribution: Recorded from various localities in the lower Indus Delta.

Tropiocolotes depressus Minton & Anderson, 1965

Tropiocolotes depressus, Minton & Anderson, 1965, *Herpetologica* 21: 59.

Type locality: Katch, Quetta Division, Balochistan, Pakistan.

Distribution: The species appears to be restricted to the hilly tracts to the north of Quetta, Balochistan.

Tropiocolotes persicus euphorbiacola Minton, S. C. Anderson & J. A. Anderson, 1970

Tropiocolotes persicus euphorbiacola, Minton, S. C. Minton & J. A. Anderson, 1970, *Proc. Calif. Acad. Sci.* 37: 333.

Type locality: Arabistan, Persia (= Khuzistan, Iran).

Distribution: ranges from the coastal plains of Bela to Haleji, near Tatta, upper Hab river valley, and Nabisar in the Thar Desert, east of the Indus, Pakistan.

Tropiocolotes helenae (Nikolsky, 1907)

Microgecko helenae, Nikolsky, 1907, *Ann. Mus. Zool. Acad. Sci. St. Petersburg*. 10: 265.

Type locality: Arabistan, Persia (= Khuzistan, Iran).

Distribution: Ranges from Iran eastwards to Las Belas and Lower Sindh, in Pakistan.

DICHOTOMOUS IDENTIFICATION KEY TO THE GECKOS OF PAKISTAN

1. Eyelids movable; digits not dilated . . . . . *Eublepharis macularius*
1'. Eyelids immovable, fused to form transparent spectacles; digits may or may not be dilated 2

2. Digits dilated 3
2'. Digits not dilated 11

3. Dilated part of the digit confined to the terminal phalanx . . *Ptyodactylus homolepis*
3'. Entire digit dilated 4

4. Subdigital lamellae undivided . . . . . *Teratolepis fasciata*
4'. Subdigital lamellae divided 5

5. Dorsum of body with enlarged keeled tubercles, arranged in regular rows 6
5'. Dorsum of body with hemispherical keelless tubercles, irregularly arranged or tubercles absent 9

6. Dorsal pattern of body comprises clearly defined broad dark saddles . . . . . *Hemidactylus triedrus*
6'. Dorsal pattern of body comprises small spots or uniformly plain 7

7. Six to 10 lamellae under toe IV, males with preanal and femoral pores . . . . . *Hemidactylus brookii*
7'. Nine to 15 lamellae under toe IV, males lacking femoral pores 8

8. Eleven to 15 lamellae under toe IV; six to nine preanal pores . . . . . *Hemidactylus persicus*
8'. Nine to 12 lamellae under toe IV; four to six preanal pores . . . *Hemidactylus turcicus*

9. Toe I <50% toe II; a continuous series of 23-33 preano-femoral pores . . . . . *Hemidactylus frenatus*
9'. Toe I >50% toe II; preanal and femoral pores separated by at least six scales . . . 10

10. Dorsum with tubercles; 20 or more femoral pores; 12 or fewer lamellae under toe IV . . . . . *Hemidactylus leschenaultii*
10'. No tubercles on dorsum; 15 or less femoral pores; 12-15 lamellar under toe IV . . . . . *Hemidactylus flaviviridis*

11. Digits straight 12
11'. Digits angularly bent between the last and penultimate phalanx 17

12. Toes fringed with flexible long pointed scales 13
12'. Toes not fringed . . . . . *Alsophylax tuberculatus*

13. Several series of large, thin, imbricate scales on tail; habitus robust 14
13'. Tail with small scales, habitus slender 15

14. Body with large cycloid scales, 30-35 round midbody . . . . *Teratoscincus scincus*
14'. Body scales small, 100 or more round midbody . . . . . *Teratoscincus microlepis*

15. Unregenerated tail shorter than body; males with fewer than five preanal pores . . . . . *Crossobamon orientalis*
15'. Tail longer than body; preanal pores in males six or more 16

16. Dorsum with numerous tubercles; dorsal pattern comprises transverse bands . . . . . *Crossobamon lumsdenii*
16'. Dorsum with few or no tubercles; dorsal pattern comprises longitudinal stripes . . . . *Crossobamon maynardi*

17. Body and tail depressed; tail longer than body 20
17'. Body and tail cylindrical; subequal in length 18

18. Three nasal scales; dorsal pattern comprises transverse bands much narrower than interspaces that tend to break up into spots on flanks . . . . . *Cyrtodactylus mintoni*
18'. Two nasal scales; dorsal pattern comprises transverse bands as broad as or broader than interspaces 23

19. Dorsal bands broader than interspaces; midventrals 85-162 . . . . . *Cyrtodactylus dattanensis*
19'. Dorsal bands break up into a reticulate pattern; midventrals 194-205 . . . . . *Cyrtodactylus battalensis*

20. Tail with even taper; limbs small, heels of adpressed hind-limb not reaching axilla . . 22
20'. Tail tapers abruptly; limbs long, slender, heels of adpressed hindlimb reach axilla or beyond 21

21. Postmentals well developed; tail-tip pointed; males with six preanal pores; a series of enlarged femoral scales . . . . . *Agamura femoralis*
21'. Postmentals absent; tail-tip blunt; males sometimes with up to two preanal pores, or none; no enlarged femoral scales . . . . . *Agamura persica*

22. Dorsum without tubercles 23
22'. Dorsum with tubercles 25

23. Internasals not differentiated from surrounding scales; four scales border naris . . . . . *Tropiocolotes depressus*
23'. Internasals well differentiated, followed by a second pair of large scales; five scales border naris 24

24. A single pair of postmentals, not in contact with each other . . . . *Tropiocolotes helenae*
24'. Two pairs of postmentals, first in contact with each other . . . . *Tropiocolotes persicus*

25. Trihedral tubercles on body and tail; body moderately depressed 26
25'. Trihedral tubercles restricted to tail; body considerably depressed 30

26. Interspaces between tubercles much smaller than the size of tubercles 27
26'. Interspaces as large as or larger than tubercles 28

27. Interorbital scales >14; dorsal tubercles often in contact; midventrals >120; snout-vent length <48 mm . . . . . *Tenuidactylus montiumsalsorum*
27'. Interorbital scales <14 ; dorsal tubercles separated by one to three imbricate scales; midventral scales <120; snout-vent length >50 mm . . . . . *Tenuidactylus kohsulaimanai*

28. Subcaudals as broad as long . . . . . *Cyrtopodion kachhensis*
28'. Subcaudals broader than long 29

29. Scales across mid-abdomen <25 . . . . . *Cyrtopodion scaber*
29'. Scales across mid-abdomen >25 . . . . . *Cyrtopodion watsoni*

30. Caudal tubercles trihedral, arising from the last annulus of the caudal segment 31
30'. Caudal tubercles non-trihedral, arising from the centre of the caudal segment . . . 33

31. Only preanal pores present in males . . 32
31'. Both preanal and femoral pores present in males . . . . . *Tenuidactylus rohtasfortai*

32. Dorsal tubercles flat and strongly keeled . . . . . *Tenuidactylus indusoani*
32'. Dorsal tubercles feebly keeled or keelless . . . . . *Tenuidactylus fortmunroi*

33. Dorsal tubercles round with raised centres . . . . . *Tenuidactylus walli*
33'. Dorsal tubercles flat, with or without keels . . . . . *Tenuidactylus baturensis*

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NOTES

Hamadryad, Vol. 18, pp. 42, 1993

OBSERVATIONS ON THE NESTING OF A GARDEN LIZARD (*CALOTES VERSICOLOR*) IN THE MALDIVES

The garden lizard, *Calotes versicolor* (Daudin) has been reported as common and widespread in the Maldive Archipelago (Phillips, 1958). It is not known how or when the colonisers reached these oceanic islands. Furthermore, it is not known if the present population is self-sustaining in the Maldives; the fact that the Archipelago is composed of hundreds of small islands means that there is not one, but many disjunct populations of this species in the Maldives. The present note provides information on successful reproduction of *Calotes versicolor* on Male Island, Maldives.

At 12:00 hours, on December 5, 1984, a garden lizard (*Calotes versicolor*) was observed digging in the ground in the front garden of the author's house on Male Island, North Male Atoll, Maldives. It was photographed while excavating a hole in bare sand. The photos show the animal straddling a hole with its hind legs, and holding the front legs flexed and pressed against the sides of its thorax. In comparison with the animal's trunk, the opening of the hole is wider and nearly as long. All the disturbed dark (= humid) sand had been thrown to the right side of the animal, the same side to which its tail was curled.

As this site was in front of the house, people frequently moved to within 2.5 m of the nesting lizard; during these approaches, it stopped digging and remained motionless for several minutes. Two hours after the animal had been first observed, the hole had been covered and smoothed over with soil.

A week after the nesting, a clear plastic cylinder, 120 mm in diameter, was placed over the nest site. This site was kept under observation, and the nest site was protected from disturbance.

On January 20, 1985, 46 days after nesting, the nest was exhumed, and six eggs were removed and photographed. The photo shows elliptical eggs, slightly over 20 mm long and nearly 15 mm wide. The six eggs were reburied at a depth of approximately 60 mm.

At 13:00 hours on February 10, 1985 (67 days after nesting), three recently-hatched lizards were found within the plastic cylinder. These were removed from the cylinder, photographed and released. The photos show hatchlings over 100 mm in total length and over 30 mm in snout-vent length.

Two hours later, two more hatchlings were found in the cylinder and released. At 7:00 hours, the following day, a sixth hatchling was found within the cylinder and released. All six hatchlings had emerged from a single hole in the ground. They were all lively and appeared to be healthy.

The nest site was partly shaded from the sun and rain by the eaves of the house; it received direct sunlight for about two hours every day. When it rained, the soil at the nest site became thoroughly soaked. Meteorological records from Male for the period December 5, 1984 to February 10, 1985, show a total of 499 hours of sunshine and 355 mm of rainfall.

During the incubation period, it was usual to observe, in the vicinity of the nest, a garden lizard of the same size and appearance as the animal that had been observed nesting.

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NEW LOCALITY RECORDS FOR *KACHUGA SYLHETENSIS* (JERDON, 1870)

(with two text-figures)

The Assam roofed turtle, *Kachuga sylhetensis* (Jerdon, 1870) is a rare and little-known species of north-eastern India and adjacent areas of Bangladesh. It is characterised by a strikingly elevated carapace with a prominent vertebral keel which resembles a pointed spike in the juveniles. The posterior marginals, typically numbering thirteen pairs, are strongly serrated. The colour of the carapace is brownish-olive, the vertebral keel being paler.

The species is confined to the Khasi and Garo Hills of Meghalaya and adjacent regions of Assam (Cachar) and Bangladesh (Khasi Hills of Sylhet). There are also reports from Nagaland (Moll, 1987). During a recent survey, *Kachuga sylhetensis* has been recorded from Manas National Park and from Sibsagar district of Assam

TABLE 1: Measurements (cm) of *Kachuga sylhetensis* from Assam. Abbreviations: SCL, straight carapace length; SCW, straight carapace width; SH, shell height.

No.	Locality	SCL	SCW	SH
1.	Ghilamara	8.7	6.7	4.9
2.	Dibru-Saikhowa	9.6	6.8	5.0
3.	"	9.8	7.2	5.2
4.	"	6.4	5.7	3.6

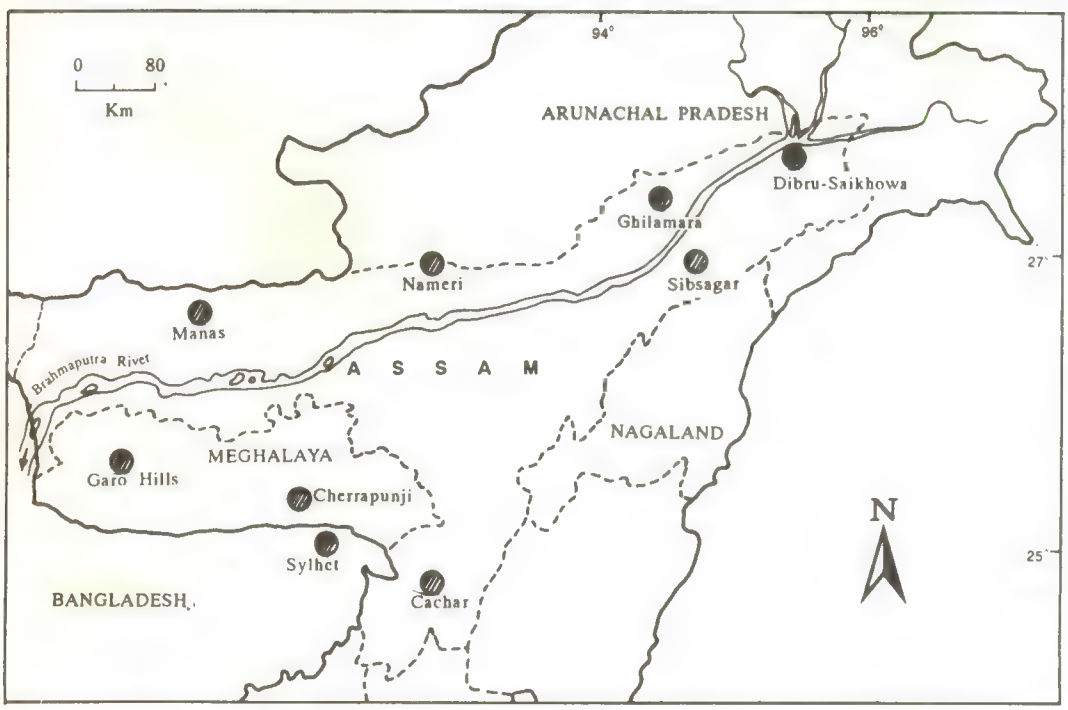

FIGURE 1: Map of north-eastern India, showing the localities from where *Kachuga sylhetensis* has been recorded (see text for details).

(Das, 1990). Thus, Manas is the first record of the species from the north bank of the Brahmaputra and Sibsagar, its eastern-most limit.

During surveys in north-eastern India, I came across *Kachuga sylhetensis* on a number of occasions. In February-March, 1990, I found a preserved specimen from Dhakuakhana, Lakhimpur district, Assam. The turtle was caught in the Sampora Nadi, near Ghilamara (27° 20'N; 94° 24'E). This is the second record of the species from the north bank of the Brahmaputra and also at the most easterly point (Fig. 1). On September 26, 1993, I examined three live specimens in the Bonko Beel area of Dibru-Saikhowa Wildlife Sanctuary, in eastern Assam (27° 40'N, 95° 20'E). These were trapped in a local fishing trap made of bamboo, called *sepa* (Fig. 2). Measurements of these turtles have been provided in Table 1.

The habitat in Ghilamara as well as in the Bonko Beel area of Dibru-Saikhowa Sanctuary are reed-beds of nal (*Arundo donax*), with sluggish *nullahs* (channels) on flat floodplains. In the Bonko Beel area, there are large numbers of *Salix tetrasperma* trees amidst the reed and grass. Elevation of both sites are below 150 m and the areas are not near any hills or foothills.

The record from Ghilamara and also from Nameri Wildlife Sanctuary (Choudhury and Bhupathy, 1992) establish that the species is fairly widespread on the north bank of the Brahmaputra. The record from Dibru-Saikhoa Sanctuary now forms the eastern-most for the species, and the ones from Ghilamara and Dibru-Saikhowa Sanctuary show that the species is not restricted to hills or hill streams in evergreen forests, as believed earlier (*cf.* Moll, 1987; Das, 1990).

I thank H. Das, then S.D.C., Ghilamara, Paniram Das, Nur Husain and S. Namasudra for their help during the survey.

FIGURE 2: Fishing traps, locally called *sepa*, used in catching *Kachuga sylhetensis* in Dibru-Saikhowa Sanctuary, eastern Assam. Arrows indicate the entrances.

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A RANGE EXTENSION OF *CALOTES NEMORICOLA* FROM THE ANAIMALAIS, WESTERN GHATS

We report a sighting of *Calotes nemoricola* Jerdon from the Anaimalai Hills, Western Ghats, in south-western India. The agamid has been hirtherto reliably reported only from the Nilgiri hills of the Western Ghats (Smith, 1943; Murthy, 1985), the Eastern Ghats records now shown to be erroneous (see Whitaker and Das, 1990). The Anaimalais and the Nilgiris are separated by the Palghat Gap, a major break in the otherwise mostly continuous ranges of the Western Ghats and acts as a barrier to the distribution of many species.

The lizard was seen on February 19, 1993, in the Karian Shola National Park (10° 27'N, 76° 50'E) at about 760 m above msl, within the Indira Gandhi Wildlife Sanctuary in the Anaimalais. The vegetation of Karian Shola has been categorised by Champion and Seth (1968) as 'west coast tropical evergreen forest'. The agamid was sighted on a sapling, about 1.2 m above the ground, along a *nullah* inside the forest. It was caught, photographed and identified using Smith's (1943) monograph and released at the site of capture.

All characteristics, except the supralabial count, match those provided by Smith (1943). Scale counts of our specimen, along with those from the aforementioned work in parentheses, have been given below.

Snout-vent length 110 mm, tail length 211 mm (145 and 330 mm, respectively, for the largest known specimen); a row of three spines above the posterior aspect of the tympanum (3-4); 11 supralabials (9-10) and 10 infralabials (9-10); midbody scale rows 38 (36-43); nuchal crest composed of about 12 lanceolate spines which gradually merge with the scales of the dorsal ridge. It remains to be seen whether the extra supralabial is a characteristic of the Annaimalai population or is an abberant count.

The ground colour of our *Calotes nemoricola* changed from bright green in the shade to greenish-brown and dark brown in the shade. It also changed to match the surroundings. The agamid was bright green on the sapling, and eluded our attempts to capture it by jumping to the ground and run into a small bamboo clump. Twenty minutes of diligent rummaging by the three of us finally yielded a dark brown agamid that was hiding at the base of the clump. It had reverted back to a bright green colour when we removed it from the bag for examination later in the evening.

The top of the head was green with some brown. The crimson iris was separated from the black pupil by a thin golden ring. The area around the eye was dark brown with some green scales and a few radial green bands were present on the upper eyelid. A blackish patch extended from the eye to behind and above the tympanum. The cheeks and the areas around the tympanum were bright yellow. The rest of the head, including the labials and the tympanum was bright green with some yellow scales. The small gular sac was yellow with some whitish scales and brown streaks with the inter-titial area pink.

The body was dark green, with three lateral transverse yellowish bars between the fore and hindlimbs. The irregular bars did not reach the

dorsal ridge. The limbs were irregularly banded bright green and brown. The tail was alternately banded light and dark brown, with some green near the base. The lanceolate spines of the prominent crest were bright green and blue. The body colours changed from dark green, through yellow, to dark brown, then paler brown and yellowish-brown. The colouration on the head changed only occasionally.

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A KING COBRA (*OPHIOPHAGUS HANNAH*) FROM A MARGINAL HABITAT

A remnant patch of primary forest persists in the upper reaches of the Chemmanaru rivulet, in the Nilgiris, while the low-lying areas have been converted to coffee plantations. Downstream, where the Chemmanaru joins the Bhavani river, in the vicinity of the town of Mettupalayam (76° 59'E; 11° 18'N), the little natural vegetation that survives is degraded, and is surrounded by fields of sugarcane.

On March 22, 1993, an adult female king cobra (*Ophiophagus hannnah*), approximately 4.1 m in length and 10.5 kg in weight, was killed by the local villagers at this lowland site. It had alternating pale and dark brown bands throughout its body and tail. The skin of the specimen has been deposited at the Forest College Museum in Mettupalayam, Tamil Nadu.

The king cobra has been reported to be restricted to undisturbed habitats, such as mangroves and rainforests, as well as dense undergrowths of coffee and tea plantations (*cf.* Whitaker, 1978), although there are records from other types of habitats, such as grasslands (Narayan and Rosalind, 1990) and even the arid north-western tracts (Parshad, 1915). The present record indicates that the species may also occur in secondary forests and near cultivated fields. Within the foothills of the Nilgiris, Lt.-Col. Phythian-Adams (1951) recorded the species from Kallar, but the area may have had primary forests during his time. One of us (SMA) has seen the king cobra on the craggy banks of a forest stream at this locality in June, 1985.

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GROWTH OF A CAPTIVE HAWKSBILL IN INDIA

In late 1977, a hatchling hawksbill turtle, *Eretmochelys imbricata* (L.) was presented to Rear Admiral Manohar Awati while he was in the Seychelles Islands. It was transported to the Madras Crocodile Bank, after being kept in an aquarium in Bombay for two weeks. At the Crocodile Bank, it was initially kept in a plastic basin, 50 cm in diameter and 18 cm deep, which was shaded from 1000-1600 hours. Later, the turtle was kept in an asbestos-cement tank, 90 cm in diameter and 30 cm deep, which was coated with several layers of rubber-based paint; this container was unshaded. Sea water was changed manually each day after the turtle was fed on chopped fish (*Tilapia* sp.), clams (*Donax* sp.) and mole crabs (*Emerita asiatica*). On May 24, 1980, it was found dead, probably from overheating of the water.

Measurements of this animal (Table 1, presented in part by Whitaker, 1980), show that its body mass increased by a factor of 36 in a period of 23 months. Assuming that hatchling weight was 15 gm (Frazier, 1984), there would have been a weight increase of about 300% during the first 2.5 years of life (in captivity).

These results are comparable to those of several other growth studies on this species (Witzell, 1983: Fig. 7). They are also comparable with results on another species, the olive ridley, *Lepidochelys olivacea* (Eschscholtz) from the nearby Central Marine Fisheries Research Institute field stations at Kovalam and Muttukadu, south of Madras city, India (Rajagopalan, 1984), where growth over the first 24 months in two experimental groups represented increases of 250% and 609%, respectively. In digestability experiments with *Chelonia mydas* at the Cayman Turtle Farm, Wood and Wood (1981) reported a 44.1% weight gain in 14-month old turtles over a 16-week period, showing the potential for rapid weight gain in the species which is most often the subject of interest for farming and ranching.

Despite a variety of drawbacks in the aquaculture of marine turtles (Dodd, 1982), the potential for rapid weight gain in a captive situation is likely to continue attracting interest for raising sea turtles for human consumption.

TABLE 1: Measurements (cm) of a captive hawksbill turtle at the Madras Crocodile Bank, India. Measurements in cm, weight in gm.

Date	Approx. age (mo)	Straight carapace length	Straight carapace width	Head width	Body weight
June 27, 1978	7	10.0	10.0	-	125
December 31, 1978	13	23.0	22.5	4.5	1,500
May 24, 1980*	30	36.0	30.0	6.0	4,500

*Plastron length = 28.6, plastron width = 25.0.

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RECENT CASES OF MAN-EATING BY THE MUGGER (*CROCODYLUS PALUSTRIS*) IN GUJARAT STATE

The mugger crocodile (*Crocodylus palustris*) is widely distributed in the Indian subcontinent. The food of the mugger ranges from insects to large mammals, and although occasional attacks on humans have been reported (see Daniel, 1983), man-eating is rare.

Two cases of man-eating crocodiles near Ahmedabad city are known from 1960 and 1965. At Chiloda village, a crocodile reportedly ate a young boy. In another incident, a pair of crocodiles attacked and ate a beggar who was sleeping on the foot-path at night, near the Kankariya tank in Ahmedabad. All these crocodiles were caught by the staff of Kankariya Zoo, Ahmedabad (D.S. Narve, Superintendent, Kankariya Zoo, *pers. comm.*).

In May, 1991, a local newspaper reported the death of a ten-year old boy, Santilal Solanki, of Dundelav village in Vadodara District, from crocodile attack. Subsequently, the Gujarat State Forest Department assigned Sayaji Baug Zoo, Vadodara, to trap this crocodile.

On June 14, 1991, along with other personnel of the zoo, I visited the lake where the incident took place. The lake is approximately 5 sq km in area and about two metres deep. We saw a large crocodile in the middle of the lake, and when we went close to the edge of the water, the crocodile came to within about five metres from us, swimming with open jaws and snorting loudly before returning to deeper waters.

On June 28, we returned to the lake with equipment to trap the crocodile. With the help of a boat and manpower on shore, we were able to confine the crocodile to a small part of the lake with a large fishing net and plastic mesh. When the crocodile surfaced to breathe, we noosed it by the neck with a wire noose. Several ropes were also fastened around the body and the crocodile was dragged out of the lake. The jaws were freed and the animal transported to the zoo.

The crocodile was a large male mugger with total body length 336.5 cm, tail length 150 cm, weighing 210 kg.

Generally, muggers are not known to attack humans. Despite the fact that there are several reservoirs and ponds in Gujarat State where crocodiles and humans may come in close proximity, there have been almost no untoward incidents. However, soon after the May 1991 incident, it was reported that a man (Latif Sidiki Sumara) was attacked by a crocodile at Rudra Mata Dam, near Bhuj in Kutch. In gathering information at these two attack sites, it was found that domestic animals (including goats, dogs, sheep and chickens) had been taken by crocodiles in the recent past. It is noteworthy that the crocodiles involved were large specimens which had become habituated to taking livestock. It is surmised that such a crocodile may lose its fear of humans and occasionally attack them as prey.

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In May, 1991, a local newspaper reported the death of a ten-year old boy, Santilal Solanki, of Dundelav village in Vadodara District, from crocodile attack. Subsequently, the Gujarat State Forest Department assigned Sayaji Baug Zoo, Vadodara, to trap this crocodile.

On June 14, 1991, along with other personnel of the zoo, I visited the lake where the incident took place. The lake is approximately 5 sq km in area and about two metres deep. We saw a large crocodile in the middle of the lake, and when we went close to the edge of the water, the crocodile came to within about five metres from us, swimming with open jaws and snorting loudly before returning to deeper waters.

On June 28, we returned to the lake with equipment to trap the crocodile. With the help of a boat and manpower on shore, we were able to confine the crocodile to a small part of the lake with a large fishing net and plastic mesh. When the crocodile surfaced to breathe, we noosed it by the neck with a wire noose. Several ropes were also fastened around the body and the crocodile was dragged out of the lake. The jaws were freed and the animal transported to the zoo.

The crocodile was a large male mugger with total body length 336.5 cm, tail length 150 cm, weighing 210 kg.

Generally, muggers are not known to attack humans. Despite the fact that there are several reservoirs and ponds in Gujarat State where crocodiles and humans may come in close proximity, there have been almost no untoward incidents. However, soon after the May 1991 incident, it was reported that a man (Latif Sidiki Sumara) was attacked by a crocodile at Rudra Mata Dam, near Bhuj in Kutch. In gathering information at these two attack sites, it was found that domestic animals (including goats, dogs, sheep and chickens) had been taken by crocodiles in the recent past. It is noteworthy that the crocodiles involved were large specimens which had become habituated to taking livestock. It is surmised that such a crocodile may lose its fear of humans and occasionally attack them as prey.

I thank the Curator and staff of the Sayaji Baug Zoo, Vadodara for their help in this operation, and D.S. Narve, Superintendent, Kankariya Zoo, Ahmedabad, for unpublished information.

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Raju Vyas, Sayaji Baug Zoo, Vadodara 390 018, Gujarat, India

Hamadryad, Vol. 18, pp. 49-51, 1993

A PRELIMINARY SURVEY OF THE WATER MONITOR (*VARANUS SALVATOR*) IN BHITARKANIKA WILDLIFE SANCTUARY, ORISSA

The water monitor (*Varanus salvator*) is widely distributed in south-east Asia, including India, Sri Lanka, Indochina, southern China and the Malay peninsula and archipelago. In the Indian subcontinent, it is found mainly in the coastal areas of Orissa (in the deltas of the rivers Brahmani and Baitarani), the Sunderbans of West Bengal and Bangladesh, Sri Lanka and on some of the islands of the Andaman and Nicobar archipelago (Whitaker and Whitaker, 1980). The distribution, in general appears similar to that of the saltwater crocodile (*Crocodylus porosus*).

Fairly large populations of *V. salvator* do, however, occur in several pockets south of Calcutta city which were once dominated by mangroves (Das, 1989). *V. salvator*, has also been reported from regions in India far from the coast. The presence of this species in Assam was reported by Anderson (1872) and Auffenberg (1986). Smith (1935) includes eastern Himalayas in the distribution of the species. Das (1989) found *V. salvator* in the Khasi and Garo hills of Meghalaya. The presence of *V. salvator* in Bhitarkanika Wildlife Sanctuary was documented by Biswas and Kar (1982).

Considering the wide range of distribution of the species, information available on the ecology of *V. salvator* is minimal. Apart from a few studies, including those of Wikramanayake and Green (1989), Andrews and Gaulke (1990) and Daltry (1991), most of the literature on *V. salvator* are on the distribution and morphometry of the species. In order to choose a site for a long-term study on the ecology of water monitor in India, the present survey was carried out at the Bhitarkanika Wildlife Sanctuary.

Bhitarkanika Wildlife Sanctuary is located on the east coast of India, in the state of Orissa, covering an area of 170 sq km. The sanctuary on its eastern side is bordered by the Bay of Bengal, and the other three sides are bounded by river Dhamara to the north, river Maipura to the south and river Brahamani to the west. The sanctuary is interspersed with numerous creeks and nullahs, and the vegetation is primarily mangrove. Some portions of the sanctuary lie on higher ground and therefore lack mangrove cover.

Four blocks of the sanctuary: North Mahisamada, South Mahisamada, Dangamala and Bhitarkanika Island were surveyed between July 3-7, 1992, covering an area of approximately 12 sq km. Both the North and South Mahisamada blocks have mangrove forest on their fringes. The rest of the areas of the two blocks have been reclaimed for agricultural purposes. The Dangamala block consists of mangrove forest dominated by *Phoenix paludosa* and *Tamarix indica*. Bhitarkanika Island block can be broadly divided into an outer low-lying mangrove forest zone and the inner central high ground. The central high ground is free of tidal inundation and the vegetation is dominated by non-mangrove species. Numerous small ponds are present in this area and the island is free of human habitation.

The survey was carried out by a motor boat in creeks and by foot through the vegetation. Animals were searched between 0600 - 1200 hours and 1600 - 1800 hours. Whenever an animal was sighted, time, habitat type and microhabitat were recorded.

I thank the Curator and staff of the Sayaji Baug Zoo, Vadodara for their help in this operation, and D.S. Narve, Superintendent, Kankariya Zoo, Ahmedabad, for unpublished information.

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Four blocks of the sanctuary: North Mahisamada, South Mahisamada, Dangamala and Bhitarkanika Island were surveyed between July 3-7, 1992, covering an area of approximately 12 sq km. Both the North and South Mahisamada blocks have mangrove forest on their fringes. The rest of the areas of the two blocks have been reclaimed for agricultural purposes. The Dangamala block consists of mangrove forest dominated by *Phoenix paludosa* and *Tamarix indica*. Bhitarkanika Island block can be broadly divided into an outer low-lying mangrove forest zone and the inner central high ground. The central high ground is free of tidal inundation and the vegetation is dominated by non-mangrove species. Numerous small ponds are present in this area and the island is free of human habitation.

The survey was carried out by a motor boat in creeks and by foot through the vegetation. Animals were searched between 0600 - 1200 hours and 1600 - 1800 hours. Whenever an animal was sighted, time, habitat type and microhabitat were recorded.

TABLE 1: Details of the fourteen sightings of *Varanus salvator* at the Bhitarkanika Wildlife Sanctuary during the present survey. Abbreviations: M.F., mangrove forest; N.M.F., non-mangrove forest. Asterisk refers to a specimen whose size was unrecorded.

Individuals	Time	Size class (feet)	Activity	Microhabitat/ substrate	Broad habitat
1	17.30	3-4	swimming	shallow water	M.F.
2	7.06	*	basking	termitarium	N.M.F.
3	7.15	4-5	foraging	leaf litter	N.M.F.
4	7.25	4	basking	under shrub	N.M.F.
5	7.45	4	foraging	pond edge	N.M.F.
6	8.14	4-5	basking	thicket	N.M.F.
7	8.37	3-4	running	open meadow	N.M.F.
8	8.54	4	foraging	mudflat	M.F.
9	9.45	5-6	foraging	pond edge	N.M.F.
10	17.05	4	swimming	shallow water	M.F.
11	9.45	4	running	dry soil	N.M.F.
12	11.17	3-4	running	leaf litter	N.M.F.
13	10.30	4	basking	mudflat	M.F.
14	12.30	3-4	foraging	shallow water	M.F.

TABLE 2: Abundance of *Varanus salvator* in the four blocks at the Bhitarkanika Wildlife Sanctuary.

Block surveyed	Hours searched	Number of lizards	Lizards/hour
Dangamala	8	3	0.4
Bhitarkanika	12	11	0.9
N. Mahisamada	3	0	0.0
S. Mahisamada	4	0	0.0

Among the four blocks surveyed, water monitors were recorded in Bhitarkanika Island and Dangamala block. Direct or indirect evidences of these lizards were not found in the North and South Mahisamada blocks. In all, 14 sightings were recorded, three in Dangamala and 11 in Bhitarkanika Island block. Details of the sightings are given in Table 1.

Three animals sighted in the Dangamala block were in the mangrove swamps. Of the eleven sightings in Bhitarkanika Island block, only twice were the animals encountered in the tidal mudflats and nine were on high ground. All the animals on the high ground were found concentrated around small ponds (locally called *arias*). Basking animals were seen in the holes of small termite mounds or in the open on bunds around the ponds. Spoors of the lizards were seen at the diurnal and nocturnal retreat sites in the hollows of *Strychnos nux-vomica* and in the holes of the trunk of *Avicennia officinalis*.

In all, 26 hours were spent in the above four blocks with an average encounter rate of 0.5 animals/hour. The abundance of the animal in the four blocks is given in Table 2.

The encounter rate was highest at the Bhitarkanika Island block (0.9 animals per hour).

Absence of human habitation and the mosaic habitat apparently favours these lizards. Looking at the scarcity of information available on the species from different parts of India, Bhitarkanika appears to be an ideal site to study the ecology of the water monitor.

I thank the staff of Bhitarkanika Wildlife Sanctuary for their support during the survey and B. C. Choudhury and S. Bhupathy, Wildlife Institute of India, who gave valuable suggestions on the paper.

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BOOK REVIEWS

THE GENERAL CARE AND MAINTENANCE OF DAY GECKOS by Sean McKeown. 1993. Advanced Vivarium Systems, Lakeside. 143 pp. Available from: Advanced Vivarium Systems, Lakeside, California 92040, U.S.A. Price: US$ 17.50.

Sean McKeown is one of the few people in the world with long experience in keeping day geckos in captivity and eminently qualified to put together this little book. *Phelsuma*, and its sister genus *Ailuronyx* are amazing geckos both from the evolutionary and distributional standpoints (Indian Ocean islands only) as well as for their spectacular colours. Described here as "living jewels of the islands of the Indian Ocean", many are brilliant green or even blue with patterns of red, yellow or orange. According to McKeown's information, *Phelsuma* grows to about 10-15 cm in length. One of the smallest is *P. breviceps* at 9 cm and the real big ones are *P. güntheri* (the Round Island day gecko) and *P. madagascariensis grandis* (the giant Madagascar day gecko), at 30 cm. Due to forest loss and the introduction of rats and cats, the huge *P. gigas* (60 cm) of the Rodrigues Island is extinct, along with the smaller *P. edwardnewtonii*.

The extensive, detailed information on care and breeding will be welcomed by enthusiasts of geckos as pets. I would personally like to see more information on the animals in the wild, though it is probably quite sparse. The first fifty pages of the book (which is printed on high quality glossy paper) are divided into eight sections on general information, housing for geckos, feeding, breeding and diseases. I was taken back to the 60's when McKeown described his visits to Ray Folson's Hermosa Reptiles (I used to sell rattlers to him) and remember the Miami animal dealers like Bill Chase with whom we used to hang around to see the latest boxes of reptiles arrive from all parts of the world. The petshop and reptile dealer debate is far from over. I'm aware of how much we learn from hobbyists who keep rare and endangered reptiles and of the badly needed money tribals and others earn in catching and selling reptiles to dealers. But the sad fact remains that a vast majority of the reptiles in the trade die very soon after capture, in transit or in the hands of well intentioned but inexperienced hobbyists. And we are talking about a trade in *millions* of reptiles each year. Obviously, a book like this one will help ensure a better survival rate in captivity. But the question is, should we really condone the keeping of rare and delicate amphibians and reptiles outside of their place of origin (where they should be kept and studied and perhaps propagated for conservation purposes)?

Most of the 57 living species and subspecies of day geckos are illustrated with good, sharp colour photographs and each is described with a standard descriptive format, generally with a larger section devoted to "management and breeding in captivity". A few minor errors have crept into the text (for example on page 73, 2 ft is calculated to be 38 cm and on page 53, *P. andamanense* is called *P. andamanensis*, and in contravention of the ICZN, on pages 128-131 and 135, the hyphenated *P. v-nigra*).

Romulus Whitaker, Center for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India

SNAKES OF MEDICINAL IMPORTANCE AND SNAKEBITE TREATMENT by Indramani Jena and Akulananda Sarangi. 1993. Ashish Publishing House, New Delhi. xxxv + 293 pp. Available from: Ashish Publishing House, 8/81, Punjabi Bagh, New Delhi 110 026, India. Price: Indian Rupees 500.

The blurb on the jacket says, "Snakebite continues to be equally mysterious as the snakes since the dawn of human civilization. Snakes have been viewed more from the zoological context of harbouring venom. The expression of clinical symptoms, and assigning grades of envenomation to a bite is occasionally encountered. Thus, snakebite remains as nonspecific as a clinical state, say fever or vomiting".

This says it all: another verbose herpetological tome with very little to say. It would have been better had Jena and Sarangi confined their sweeping inaccuracies to India; but they have taken on the whole world, and the facts get surprisingly startling as they get further and further from the shores of India. But don't jump to conclusions and assume that data from the Subcontinent are accurate. On page 31, *Trimeresurus gramineus* has been flung into Bangladesh and the Andaman and Nicobar Islands, and *Enhydrina schistosa* pronounced the most poisonous snake in the world. The same page has an example of the many colourful myths which are offered as scientific facts: the bamboo pit viper is stated to "anchor to a branch by its tail and bite as far as it can reach".

Basic scientific nomenclatural rules are not followed. Both generic and specific names are capitalized and there seems to be a preference for outdated names: *Agkistrodon* instead of *Calloselasma* for *C. rhodostoma*, and so on *ad nauseum*. In the distribution map on page 12, *Naja kaouthia* is way too far south and west. *Echis carinatus*, which is common in Andhra Pradesh, is not shown there at all.

Moving on to other regions, the distribution map for Papua New Guinea on page 47 is highly inaccurate. Australia, a country which has a mere 2-3 deaths per year due to snakebite (Mirtschin *et al.*, 1990) is classified as one of the world's main snakebite regions. These are just a few indications of the misleading, unresearched, sloppy presentation for which we are asked to pay Rupees 500. Even the photographs offer no compensation. Some are upside-down (page 61) and those which are not, are blurry and unclear (page 43).

In short, there is little reason for this book being published. The current authoritative international book on the subject is Gopalakrishnakone and Chou (1990). What India really needs now is an uptodate study on the snakebite situation, the latest data being over 20 years old!

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Zai Whitaker, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India.

COX, M. J. 1991. The snakes of Thailand and their husbandry. Krieger Publishing Company, Malabar, Florida. 526 pp. Available from Krieger Publishing Company, Krieger Drive, Malabar, Florida 32950, U.S.A. Price US$ 69.50.

Visitors to Bangkok brave enough to venture out of the steamy life of nightclubs, massage parlors and go-go bars into the outskirts of the city will quickly realise that Thailand has been endowed with an incredible herpetological biodiversity.

Although this fauna is almost entirely Oriental in affinities, taxa from the Eastern Palaearctic are also represented. Endemicity among Thailand's snake fauna is high, the country being a mosaic of large river systems and mountain ranges that presumably have stopped or impeded the dispersal of many taxa. As in other parts of tropical Asia, the herpetofauna has been grossly understudied, although the recent description of new species, life history notes and new distributional records, mostly by local biologists, indicate that this is changing.

Not a local biologist, but someone who has lived in Thailand for many years, Merel Jack Cox teaches English at the American Language Center at Bangkok. Cox is an amateur herpetologist, and brings us this thick tome under review. Since the last word on Thai serpents has been the monograph by Taylor (1965), and as this work depicted museum specimens, Cox's book, printed on good-quality paper and with plenty of colour photographs is a useful aid for the identification of snakes in Thailand as well as in many other parts of south-east Asia.

The book is organised into two sections. The first composed of: a dedication, a commentary on Thai and other Asian beliefs about snakes (The Year of the Snake), Foreword (by Harvey B. Lillywhite), Preface (that include species added to/ excluded from the Thai fauna since the work of Taylor, and major range extensions within the country), Acknowledgements, and finally, the main body of introductory text.

Following the short (2 pages) General Introduction is the section on the geography of Thailand (15 pages), which described the physiographical units within the country, the attitude of local people to snakes and snake bites in Thailand. What follow are longish chapters on miscellaneous aspects of the morphology, including scalation and biology (16 pages), general husbandry (16 pages) and medical aspects of husbandry (19 pages) of snakes. Section Two deals with the species accounts and the traditionally accepted scheme of classification, at least of snake families, has been followed. Each family, subfamily and genus has been described briefly, and the species accounts themselves include the current scientific name, recommended English name, the Thai name (in Thai script), a brief description of colour and scalation, a short account of the biology (if known) and distribution of the taxon. Notes on husbandry being only for the more familiar forms, it becomes apparent that we still know very little about the life histories of most species.

A substantial portion of the last section of the book is devoted to various miscellany. Included here is a listing of the herpetological societies of the world, climatic data for Thailand, a list of snakes protected in Thailand, an analysis of the Thai vernacular for various snakes (surprisingly without their scientific or standard English names, hence readers will be kept as ignorant about the identity of the snakes!) and finally, a 12 page references section and the index.

The quality of the colour photos is extremely variable, and range from excellent (e.g., *Elaphe porphyracea*, Plate 44) to appalling (e.g., the cover photograph of *Chrysopelea pelias*, whose head is partially hidden). In addition, photographs have been printed upside down (e.g., *Ahaetulla prasinus*, Plate 22; *Boiga drapiezii*, Plate 28), sideways (*Chrysopelea paradisi*, Plate 35) or are not sharp (e.g., hatchling *Python reticulata*, Plates 17 and 18; juvenile *Rhabdophis subminiatus subminiatus*, Plate 80). Many of the photographs are of posed snakes that

have been taken carelessly, with windows, doors and framed photographs in the background, although mercifully, few fingers appear. Perhaps the most interesting photographs appear between pages 308 and 309: the hood markings of the various specimens of *Naja kaouthia* from Thailand. Line drawings of the heads of snakes that show scalation, often more critical for identification, are of uniformly poor quality, probably having been scanned and printed from the original line-drawings using a very crude pixel grid. To be fair to the author, most of the species have been illustrated for the very first time, for which both the author and the team of photographers (notably my good friend, Jarujin Nabhitabhata, of the Thailand Institute for Scientific and Technological Research) deserve full praise.

At $69.50, it is expensive and will remain out of the reach of many biologists who would have most benefited from it. Printing a limited edition of a specialised book can be a risky investment for a publisher, but a cheaper 'Third World' edition, perhaps in paperback, needs to be prepared in the near future, to fulfill Jack Cox's goal of popularising the study of the snakes of Thailand.

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Indraneil Das, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India.

THE WORLD OF TURTLES AND CROCODILES by Zai Whitaker and Rom Whitaker (crocodiles) and Indraneil Das (turtles). 1993. National Book Trust, New Delhi. 64 pp. Available from: Madras Crocodile Bank, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, Tamil Nadu, India. Price: US$ 5.00.

Once in a while you get a booklet in your hands that makes you think "Great, more people should read this!". *The World of Turtles and Crocodiles* is like that, a compact little book filled with information about what turtles and crocodiles are and what they do on this earth. We, readers of *Hamadryad*, have our own various reasons to like turtles and crocs and to hope for their survival in the wild. We, unfortunately, are but a tiny minority, and while our efforts are not wasted, the survival of many if not most animal species will depend on how the general public sees them. While most people like turtles, or at least feel neutral about them, the public image of crocodiles is less positive.

For a long time, the Whitakers have been actively working to alleviate the plight of some of India's endangered reptiles, by writing about them, producing documentaries, by carrying out research and conservation projects, and by setting up facilities and organisations like the Madras Snake Park, the Madras Crocodile Bank, the Irula Tribal Cooperative and others. Along the way, they have attracted and stimulated a band of dedicated conservationists.

The World of Turtles and Crocodiles provides a good introduction to the biology, ecology and conservation of these reptiles for school children, for those with a beginning interest in reptile biology. On 64 pages, it provides answers to all the obvious questions, such as where they live, what they eat, how they reproduce and how they are used by man, as well as lots of little facts that you had almost forgotten. As such, it also provides a nice summary of facts not normally found in the average biological textbook, of considerable use to undergraduate students. The booklet is generously illustrated with black-and-white photos and drawings, among them some very good ones, which show portraits and behaviour of turtles and crocodiles. The text itself is printed in a large size, easy to read, and the layout shows minumum useless space. There are a few bits of information placed in odd places, such as inserting the morphological differences between crocodiles and alligators in the section on croco-

have been taken carelessly, with windows, doors and framed photographs in the background, although mercifully, few fingers appear. Perhaps the most interesting photographs appear between pages 308 and 309: the hood markings of the various specimens of *Naja kaouthia* from Thailand. Line drawings of the heads of snakes that show scalation, often more critical for identification, are of uniformly poor quality, probably having been scanned and printed from the original line-drawings using a very crude pixel grid. To be fair to the author, most of the species have been illustrated for the very first time, for which both the author and the team of photographers (notably my good friend, Jarujin Nabhitabhata, of the Thailand Institute for Scientific and Technological Research) deserve full praise.

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Once in a while you get a booklet in your hands that makes you think "Great, more people should read this!". *The World of Turtles and Crocodiles* is like that, a compact little book filled with information about what turtles and crocodiles are and what they do on this earth. We, readers of *Hamadryad*, have our own various reasons to like turtles and crocs and to hope for their survival in the wild. We, unfortunately, are but a tiny minority, and while our efforts are not wasted, the survival of many if not most animal species will depend on how the general public sees them. While most people like turtles, or at least feel neutral about them, the public image of crocodiles is less positive.

For a long time, the Whitakers have been actively working to alleviate the plight of some of India's endangered reptiles, by writing about them, producing documentaries, by carrying out research and conservation projects, and by setting up facilities and organisations like the Madras Snake Park, the Madras Crocodile Bank, the Irula Tribal Cooperative and others. Along the way, they have attracted and stimulated a band of dedicated conservationists.

The World of Turtles and Crocodiles provides a good introduction to the biology, ecology and conservation of these reptiles for school children, for those with a beginning interest in reptile biology. On 64 pages, it provides answers to all the obvious questions, such as where they live, what they eat, how they reproduce and how they are used by man, as well as lots of little facts that you had almost forgotten. As such, it also provides a nice summary of facts not normally found in the average biological textbook, of considerable use to undergraduate students. The booklet is generously illustrated with black-and-white photos and drawings, among them some very good ones, which show portraits and behaviour of turtles and crocodiles. The text itself is printed in a large size, easy to read, and the layout shows minumum useless space. There are a few bits of information placed in odd places, such as inserting the morphological differences between crocodiles and alligators in the section on croco-

dile farming; it would have been more logical to tack it on to a preceding section dealing with the differences between crocodiles and the gharial. Of course, a size-limited, non-technical text cannot provide as much detail as one would like. For example, not all side-necked (= Pleurodire) turtles have long necks (page 9), only some of the family Chelidae, which never occurred in Asia; the Asian Pleurodires, known only from fossils, all belonging to the family Pelomedusidae, which look so much like a "normal" turtle that even most biologists have trouble differentiating them from the head-withdrawing Cryptodire turtles. I cannot help thinking that the often-repeated report of *Chitra* softshells attacking and sinking boats has its origin in a single large *Chitra* once upsetting a small boat while on the wrong end of a harpoon or fish hook.

But overall, these minor points detract little from the book. It is a lovely work that invites one to read it, and hopefully, many will. After reading, few will not be convinced of the rationale to conserve turtles and crocodiles, not just in India but world-wide. The price, seven rupees, makes it easy for anyone to obtain this book and it will eventually be printed in all the 15 major languages of India. In fact, the cause of conservation would be greatly assisted if copies of this booklet could be distributed to every primary and secondary school in India. The book is another tribute to the leading role of the Madras Crocodile Bank in the Indian conservation movement, and sets a high standard to be followed for similar projects in other countries. It is by providing information at the village level, to the men and women along the river and their children, that we can most effectively hope to safeguard the future of the world's wildlife.

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CURRENT LITERATURE IN ASIAN HERPETOLOGY

Compiled by Indraneil Das and Harry V. Andrews

JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY

89 (3) 1992, 90 (1 & 2) 1993

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KARTHIKEYAN, S. *Amphiesma monticola* (Jerdon) at Bhadra Wildlife Sanctuary, Karnataka. 90(1): 114.

_____ . On the breeding of the green calotes *Calotes calotes* (Linn). 90(2): 295.

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PRASAD, J. N. Review of distribution of condanarus sandsnake *Psammophis condanarus* (Merrem). 89(3): 382.

RAO, P. & A. G. SEKAR. Occurrence of Cantor's blackheaded snake *Sibynophis sagittarius* in Sriharikota, Andhra Pradesh. 90(1): 114.

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VYAS, R. & B. H. PATEL. Range extension of the striped grass skink *Mabuya dissimilis* (Hallowell, 1857). 89(3): 382.

_____& _____ . Captive breeding of the Indian roofed terrapin *Kachuga tecta* (Gray). 90(1): 109-112.

ASIATIC HERPETOLOGICAL RESEARCH

5 1993

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LIU, W.-Z. & D.-T. YANG. A karyosystematic study of the genus *Bombina* from China (Amphibia: Discoglossidae). 137-142.

MANILO, V. V. A karyosystematic study of the plate tailed geckos of the genus *Teratoscincus* (Sauria, Gekkonidae). 109-111.

_____& M. L. GOLUBEV. Karyotype information on some toad agamas of the

Phrynocephalus guttatus species group (Sauria: Agamidae) of the former USSR. 105-108.

MEZHZHERIN, S. & M. L. GOLUBEV. Allozyme variation and genetic relationships within the *Phrynocephalus guttatus* species group (Sauria: Agamidae) in the former USSR. 59-64.

SCHAMMAKOV, S., C. ATAEV & E. A. RUSTAMOV. Herpetogeographical map of Turkmenistan. 127-136.

SMITH, B. E. Notes on a collection of squamate reptiles from Eastern Mindanao, Philippine Islands. Part I: Lacertilia. 85-95.

_____. Notes on a collection of squamate reptiles from Eastern Mindanao, Philippines Islands. Part II: Serpentes. 96-102.

SONG, J.; Y. XIONG, W. WANG & X. PU. A study on the purification and pharmacological properties of two neurotoxins from the venom of the king cobra (*Ophiophagus hannah*). 143-146.

TUNIYEV, B. S. & S. M. SHAMMAKOV. *Coluber atayevi* sp. nov. (Ophidia, Colubridae) from the Kopet-Dag Mountains of Turkmenistan. 1-10.

WANG, P.-C. & J.-H. ZHANG. Resting metabolic rate in three age-groups of *Alligator sinensis*. 112-116.

WANG, Y. & H. WANG. Geographic variation and diversity in three species of *Phrynocephalus* in the Tengger Desert, Western China. 65-73.

WEI, G, N. XING, D. LI, G. WU & X. SONG. Karyotype, C-band and Ag-Nors study of three stink frogs. 45-50.

ZHANG, Y., Y. XIONG & & C. BON. Effects of Chinese snake venoms on blood coagulation, purified coagulation factors and synthetic chromogenic substrates. 117-126.

ZHONG, C. First records for *Ophisaurus harti* and *Python molurus bivittatus* from Jiangxi Province, China. 103-104.

HERPETOLOGICAL MONOGRAPH

(7) 1993 (Symposium: Amphibian relationships- Phylogenetic analysis of morphology and molecules)

CANNATELLA, D. C. & D. M. HILLIS. Amphibian relationships: Phylogenetic analysis of morphology and molecules. 1-7.

FORD, L. S. & D. C. CANNATELLA. The major clades of frogs. 94-117.

HASS, C. A., R. A. NUSSBAUM & L. R. MAXSON. Immunological in-sights into the evolutionary history of caecilians (Amphibia: Gymnophiona): Relationships of the Seychellean caecilians and a preliminary report on family-level relationships. 56-63.

HEDGES, S. B. & L. R. MAXSON. A molecular perspective on Lissamphibian phylogeny. 27-42.

_____, R. A. NUSSBAUM & L. R. MAXSON. Caecilian phylogeny and biogeography inferred from mitochondrial DNA sequences of the 12S rRNS and 16S rRNA genes (Amphibia: Gymnophiona). 64-76.

HILLIS, D. M., L. M. AMMERMAN, M. T. DIXON & R. O. DE SA. Ribosomal DNA and the phylogeny of frogs. 118-131.

LARSON, A. & W. W. DIMMICK. Phylogenetic relationships of the salamander families: An analysis of congruence among morphological and molecular characters. 77-93.

MILNER, A. R. The Paleozoic relatives of Lissamphibians. 8-27.

WAKE, M. Non-traditional characters in the assessment of caecilian phylogenetic relationships. 42-55.

THE SNAKE

24 (2) 1992

KAMURA, T. & M. NISHIMURA. Two years survival of *Trimeresurus elegans* (Viperidae) without food consumption. 165-166.

KHAW, A., K. A. THA, H. PE, K. P. P. KYAW & S. KUN. Reversion of formaldehyde linkage in Russell's viper venom toxoid on storage. 147-150.

SAWAI, Y. Venomous snakes and snakebite treatment in Asia. 129-141.

TORIBA, M. Karyotype of red-tailed pipe snake, *Cylindrophis rufus* (Uropeltidae: Cylindrophiinae). 143-146.

WEI, G, N. XING, J. WANG & D. LI. Karyotype, C-band and Ag-NORs of *Elaphe mandarina*. 151-155.

25 (1) 1993

GOPALAKRISHNAKONE, P. & E. KOCHVA. Histological features of the venom apparatus of sea snake *Lapemis curtus*. 27-37.

KAWAMURA, Y., A. SAKAI, Y. SAWAI, M. NOZAKI, N.P. WANG & S.-X. TAN. Studies on the preparation of rabbit antivenom against the venom of *Hydrophis cyanocinctus*. 1-3.

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MORI, A. A note on the sidewinding locomotion in two colubrid snakes, *Opisthotropis typica* and *Pseudoxenodon macrops*. 67-70.

PAN, W.-M., J.-F. ZHANG, W.-HAO, W.-X. LU, J.-S. JIANG, M.-F. DING & Z.-X. CHEN. The effect of savate-3 on t-PA and PAI in rabbits. 5-7.

TARE, T. G. & D. M. RENAPURKAR. Comparative studies on yield of venom in *Naja naja* and *Bungarus caeruleus*, snakes of different length groups. 73-75.

TORIBA, M. Present location of the type specimens described by Maki. 71-72.

YOKOYAMA, F. & H. YOSHIDA. The reproductive cycle of the male habu, *Trimeresurus flavoviridis*. 55-62.

ZUG, G. R. & I. INEICH. Review of the biology and morphology of the Fijian bola, *Ogmodon vitianus* (Elapidae). 9-20.

25 (2) 1993

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DUTTA, S. K. & L. N. ACHARJYO. Additions to the herpetofauna of Orissa, India. 149-150.

KHAIRE, A. & N. KHAIRE. Occurrence of brown whip snake *Ahaetulla pulverulenta* (Dum. & Bibr.) in Pune, India. 147-148.

KUDRYAVTSEV, S. V., S. V. MAMET & M. PROUTKINA. Keeping and breeding in captivity snakes of Russia and adjacent countries (within the former USSR). Part II. 121-130.

MURTHY, T. S. N., D. P. SANYAL & B. DATTAGUPTA. Rare snakes of India. 135-140.

NANAYAKKARA, G. L. A. A bite by *Hypnale hypnale* in Sri Lanka. 151.

PAIK, N.-K., M.-S. MIN, J.-H. SHIM, S.-Y. YANG & M. TORIBA. Isozyme analysis of the species of the genus *Agkistrodon* in Far Eastern Region. 99-104.

YAMAMOTO, E. & T. OKAYAMA. Oviducal eggs of *Achalinus spinalis* collected at Odacho, Ehime pref., Japan. 145-146.

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1(3) 1992, 2(1), 2(2) 1993

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ANNOUNCEMENTS

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Sri Lanka has a rich and diverse herpetofauna, with 49 species of amphibians and 172 species of reptiles. In all, 118 (53%) of the herpetofauna are endemic to the island, the ratio of species of amphibians and reptiles to area being the highest among the countries of Asia. This diversity is due to the large number of ecological systems in the island, including rainforests. However, deforestation that contribute to habitat destruction of many of these species is high, and nearly 80% of the primary forests have been destroyed. As a result, three taxa are extinct, five endangered, 11 vulnerable, 31 rare, two threatened by commerce, 81 threatened by other factors and for 78, the status is unknown.

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2. Conduct *in situ* and *ex situ* conservation, protection of species and their habitats and to establish field research laboratories.

For membership, write:

Anslem De Silva, President, ARROS, Faculty of Medicine, University of Peradeniya, Sri Lanka. Tel: 08-88130. Fax: 948-32572.

Ashoka Jayawickrama, Secretary ARROS, 15/1, Dolosbage Road, Gampola, Sri Lanka.

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